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A1-F18AC-NFM-000

NATOPS FLIGHT MANUAL
NAVY MODEL
F/A-18A
AND
TF/A-18A
161353 AND UP
AIRCRAFT

McDonnell Aircraft

THE AIRCRAFT 1
INDOCTRINATION 2
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ISSUED BY AUTHORITY OF THE CHIEF OF NAVAL OPERATIONS AND UNDER THE DIRECTION OF THE COMMANDER, NAVAL AIR SYSTEMS COMMAND.

1 APRIL 1983
Change 1 - 15 July 1983 (A1-F18AC-NFM-00A)

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INTERIM CHANGE SUMMARY

The following Interim Changes have been canceled or previously incorporated in this manual:

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1 thru 12	

The following Interim Changes have been incorporated in this Change/Revision:

INTERIM CHANGE NUMBER	REMARKS/PURPOSE

Interim Changes Outstanding - To be maintained by the custodian of this manual:

INTERIM CHANGE NUMBER	ORIGINATOR/DATE (or DATE/TIME GROUP)	PAGES AFFECTED	REMARKS/PURPOSE

SUMMARY OF APPLICABLE TECHNICAL DIRECTIVES

INFORMATION RELATING TO THE FOLLOWING TECHNICAL DIRECTIVES HAS BEEN INCORPORATED IN THIS MANUAL

CHANGE NUMBER	ECP NUMBER	DESCRIPTION	VISUAL IDENTIFICATION	EFFECTIVITY
ASC 006	00044C1	Mission computer OFP reload	DDI configuration display MC1 150 & MC2 150	All
ASC 008	00044	Installs 7.3 PROM	None	Thru 161528
ASC 009	00044	INS OFP reload EJS 74–A1176	DDI configuration display INS 200	161353 thru 161519
	00003	Adds AN/ALR–67(v) radar warning	RWR azimuth indicator	161702 and up
	00019	INS OFP load	DDI configuration display INS 300	161520 and up
	00023	330 gallon external tanks	Round tanks	
	00026	Adds L (R) IN TEMP caution displays	None	161702 and up
	00033	Adds fuel/air heat exchangers	None	161520 and up
	00044	AOA indexer/approach light switch point change EJS 74–A1116	None	161520 and up
	00055	Adds tank 4 motive flow shutoff valve to improve negative G flight time	None	161925 and up
	00072	Fuel sequencing for CG control	None	161520 and up
	00074	Adds sealed lead acid battery	None	161702 and up
	00077	Replaces feed tank ejector pumps with turbo pumps	None	161925 and up
ASC 011	00095	Radar computer-power supply OFP reload	DDI configuration display: RDR 101B	161353 and up
ASC 013	00095	Armament computer OFP reload	DDI configuration display: SMS 110B	161353 and up
ASC 015	00149	Mission computer OFP reload	DDI configuration display MC1 210 & MC2 210	All
	00155	Omnibus software update	DDI configuration display: SMS 120B, RDR 102 1, MC1 300-XXX, MC2 300-YYY	161925 and up

INFORMATION RELATING TO THE FOLLOWING RECENT TECHNICAL DIRECTIVES WILL BE INCORPORATED IN A FUTURE CHANGE.

CHANGE NUMBER	ECP NUMBER	DESCRIPTION	VISUAL IDENTIFICATION	EFFECTIVITY

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D.C. 20350

LETTER OF PROMULGATION

1. The Naval Air Training and Operating Procedures Standardization Program (NATOPS) is a positive approach toward improving combat readiness and achieving a substantial reduction in the aircraft accident rate. Standardization, based on professional knowledge and experience, provides the basis for development of an efficient and sound operational procedure. The standardization program is not planned to stifle individual initiative, but rather to aid the Commanding Officer in increasing his unit's combat potential without reducing his command prestige or responsibility.

2. This manual standardizes ground and flight procedures but does not include tactical doctrine. Compliance with the stipulated manual procedure is mandatory except as authorized herein. In order to remain effective, NATOPS must be dynamic and stimulate rather than suppress individual thinking. Since aviation is a continuing, progressive profession, it is both desirable and necessary that new ideas and new techniques be expeditiously evaluated and incorporated if proven to be sound. To this end, Commanding Officers of aviation units are authorized to modify procedures contained herein, in accordance with the waiver provisions established by OPNAVINST 3510.9 series, for the purpose of assessing new ideas prior to initiating recommendations for permanent changes. This manual is prepared and kept current by the users in order to achieve maximum readiness and safety in the most efficient and economical manner. Should conflict exist between the training and operating procedures found in this manual and those found in other publications, this manual will govern.

3. Checklists and other pertinent extracts from this publication necessary to normal operations and training should be made and may be carried in Naval Aircraft for use therein. It is forbidden to make copies of this entire publication or major portions thereof without specific authority of the Chief of Naval Operations.

R.F. SCHOULTZ
Vice Admiral, USN
Deputy Chief of Naval Operations
(Air Warfare)

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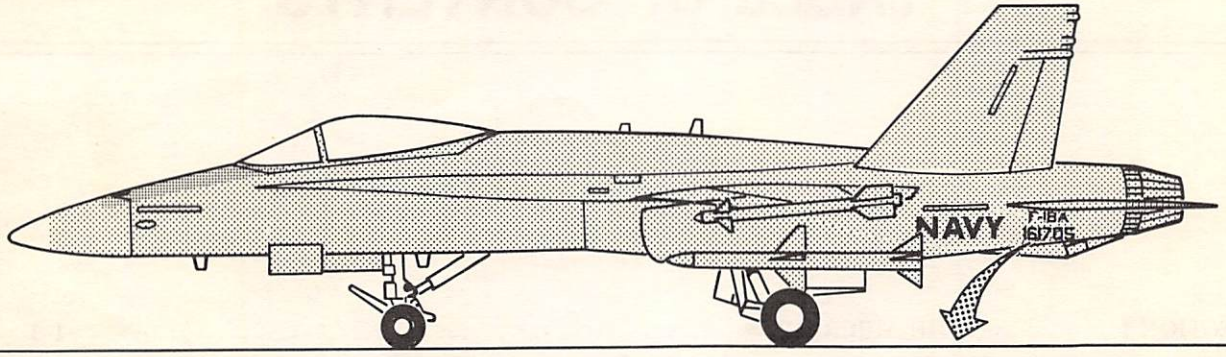

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FOREWORD

SCOPE

The NATOPS Flight Manual is issued by the authority of the Chief of Naval Operations and under the direction of Commander, Naval Air Systems Command in conjunction with the Naval Air Training and Operating Procedures Standardization (NATOPS) Program. This manual contains information on all aircraft systems, performance data, and operating procedures required for safe and effective operations. However, it is not a substitute for sound judgement. Compound emergencies, available facilities, adverse weather or terrain, or considerations affecting the lives and property of others may require modification of the procedures contained herein. Read this manual from cover to cover. It's your responsibility to have a complete knowledge of its contents.

APPLICABLE PUBLICATIONS

The following applicable publications complement this manual:

A1-F18AC–NFM–100 (Supplement)
A1-F18AC–NFM–500 (Pocket Checklist)
A1-F18AC–NFM–600 (Servicing Checklist)
A1-F18AC–NFM–700 (Functional Checkflight Checklist)
A1-F18AC–TAC–000 (Volume I Tactical Manual)
A1-F18AC–TAC–010 (Volume II Tactical Manual)
A1-F18AC–TAC–100 (Volume III Tactical Manual)
A1-F18AC–TAC–300 (Tactical Manual Pocket Guide)

HOW TO GET COPIES

Each flight crewmember is entitled to personal copies of the NATOPS Flight Manual and appropriate applicable publications.

Automatic Distribution

To receive future changes and revisions to this manual or any other NAVAIR aeronautical publication automatically, a unit must be established on an automatic distribution list maintained by the Naval Air Technical Services Facility (NATSF). To become established on the list or to change existing NAVAIR publication requirements, a unit must submit the appropriate tables from NAVAIR 00–25DRT–1 (Naval Aeronautic Publications Automatic Distribution Requirement Tables) to NATSF, Code 321, 700 Robins Avenue Philadelphia, PA 19111. Publication requirements should be reviewed periodically and each time requirements change, a new NAVAIR 00–25DRT–1 should be submitted. NAVAIR 00–25DRT–1 only provides for future issues of basic, changes, or revisions and will not generate supply action for the issuance of publications from stock. For additional instructions, refer to NAVAIRINST 5605.4 series and Introduction to Navy Stocklist of Publications and Forms NAVSUP Publication 2002 (S/N 0535–LP–004–0001).

Additional Copies

Additional copies of this manual and changes thereto may be procured by submitting DD Form 1348 to NAVPUBFORMCEN Philadelphia in accordance with Introduction to Navy Stocklist of Publications and Forms NAVSUP Publication 2002.

UPDATING THE MANUAL

To ensure that the manual contains the latest procedures and information, NATOPS review conferences are held in accordance with OPNAVINST 3510.9 series.

CHANGE RECOMMENDATIONS

Recommended changes to this manual or other NATOPS publications may be submitted by anyone in accordance with OPNAVINST 3510.9 series.

Routine change recommendations are submitted directly to the Model Manager on OPNAV Form 3500–22 shown on the next page. The address of the Model Manager of this aircraft is:

Commanding Officer
VFA–125
U. S. Naval Air Station
LeMoore, CA 93245
Attn: F/A–18 Model Manager
Autovon: 949–3613
Commercial: (209) 998–3613

Change recommendations of an URGENT nature (safety of flight, etc.,) should be submitted directly to the NATOPS Advisory Group Member in the chain of command by priority message.

NATOPS/TACTICAL CHANGE RECOMMENDATION
OF NAV FORM 3500/22(5–69) 0107–722–2002

DATE

TO BE FILLED IN BY ORIGINATOR AND FORWARDED TO MODEL MANAGER

FROM (originator)	Unit
TO (Model Manager)	Unit

Complete Name of Manual/Checklist	Revision Date	Change Date	Section/Chapter	Page	Paragraph

Recommendation (be specific)

☐ CHECK IF CONTINUED ON BACK

Justification

Signature	Rank	Title

Address of Unit or Command

TO BE FILLED IN BY MODEL MANAGER (Return to Originator)

FROM

DATE

TO

REFERENCE
(a) Your Change Recommendation Dated ____________

☐ Your change recommendation dated ____________ is acknowledged. It will be held for action of the review conference planned for ____________ to be held at ____________

☐ Your change recommendation is reclassified URGENT and forwarded for approval to ____________ ____________ by my DTG ____________

/S/____________ MODEL MANAGER ____________ AIRCRAFT

YOUR RESPONSIBILITY

NATOPS Flight Manuals are kept current through an active manual change program. Any corrections, additions, or constructive suggestions for improvement of its content should be submitted by routine or urgent change recommendation, as appropriate, at once.

NATOPS FLIGHT MANUAL INTERIM CHANGES

Flight Manual Interim Changes are changes or corrections to the NATOPS Flight Manuals promulgated by CNO or NAVAIRSYSCOM. Interim Changes are issued either as printed pages, or as a naval message. The Interim Change Summary page is provided as a record of all interim changes. Upon receipt of a change or revision, the custodian of the manual should check the updated Interim Change Summary to ascertain that all outstanding interim changes have been either incorporated or canceled; those not incorporated shall be recorded as outstanding in the section provided.

CHANGE SYMBOLS

Revised text is indicated by a black vertical line in either margin of the page, adjacent to the affected text, like the one printed next to this paragraph. The change symbol identifies the addition of either new information, a changed procedure, the correction of an error, or a rephrasing of the previous material.

WARNING, CAUTIONS, AND NOTES

The following definitions apply to "WARNINGS", "CAUTIONS", and "NOTES" found throughout the manual.

WARNING

An operating procedure, practice, or condition, etc., which may result in injury or death, if not carefully observed or followed.

CAUTION

An operating procedure, practice, or condition, etc., which may result in damage to equipment if not carefully observed or followed.

NOTE

An operating procedure, practice, or condition, etc., which is essential to emphasize.

WORDING

The concept of word usage and intended meaning which has been adhered to in preparing this Manual is as follows:

"Shall" has been used only when application of a procedure is mandatory.

"Should" has been used only when application of a procedure is recommended.

"May" and "need not" have been used only when application of a procedure is optional.

"Will" has been used only to indicate futurity, never to indicate any degree of requirement for application of a procedure.

AIRSPEED

All airspeeds in this manual are in knots calibrated airspeeds unless stated in other terms.

MANUAL DEVELOPMENT

This Flight Manual was prepared using a concept that provides the aircrew with information for operation of the aircraft, but detailed operation and interaction is not provided. This concept was selected for a number of reasons: reader interest increases as the size of a technical publication decreases, comprehension increases as the technical complexity decreases, and accidents decrease as reader interest and comprehension increase.

To implement this streamlined concept, observance of the following rules were attempted:

a. The pilot shall be considered to have above–average intelligence and normal (average) common sense.
b. No values (pressure, temperature, quantity, etc.) which cannot be read in the cockpit are stated, except where such use provides the pilot with a value judgement.
c. Only the information required to fly the airplane is provided.
d. Notes, Cautions, and Warnings are held to an absolute minimum, since, almost everything in the manual could be considered a subject for a Note, Caution, or Warning.
e. No Cautions or Warnings or procedural data are contained in the Descriptive Section, and no abnormal procedures (Hot Starts, etc.) are contained in the Normal Procedures Section.
f. Notes, Cautions and Warnings will not be used to emphasize new data.
g. Multiple failures (emergencies) are not covered.
h. Simple words in preference to more complex or quasi–technical words are used and, unnecessary and/or confusing word modifiers are avoided.

A careful study of the Flight Manual will probably disclose a violation of each rule stated. In some cases this is the result of a conscious decision to make an exception to the rule. In many cases, it only demonstrates the constant attention and skill level that must be maintained to prevent slipping back into the old way of doing things.

In other words, the "Streamlined" look is not an accident, it takes constant attention for the Flight Manual to keep its lean and simple concept to provide the pilot with the information required.

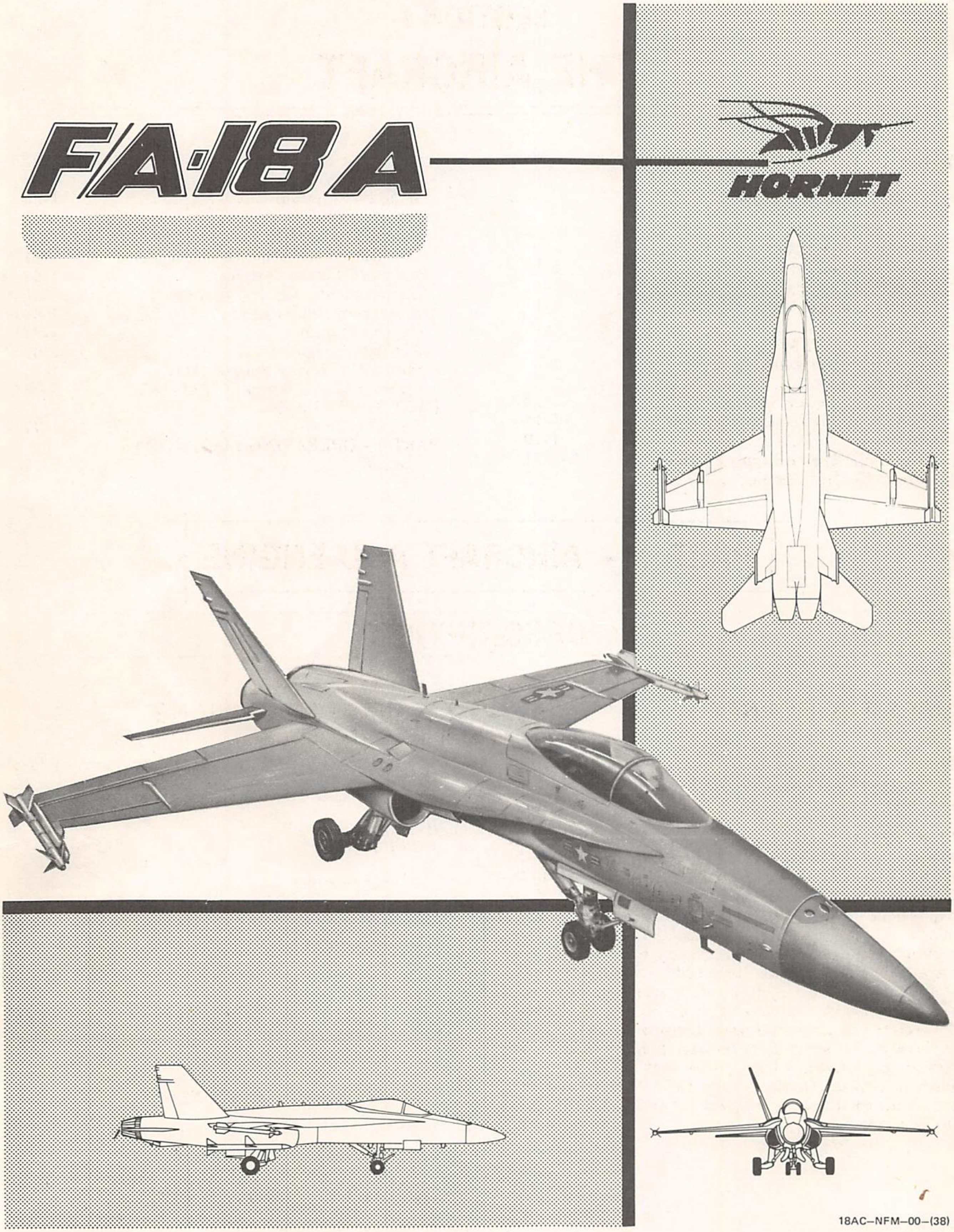

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Figure 1–0. Three–quarter View

SECTION I

THE AIRCRAFT

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PART 1 - AIRCRAFT AND ENGINE

DESCRIPTION

MEET THE HORNET

The F/A–18A Hornet is a single–place fighter/attack airplane built by McDonnell Aircraft Company. See figure 1–1 for general arrangement and Cockpits Foldout section, for cockpit arrangement. It is powered by two General Electric F404–GE–400 turbofan engines with afterburner. The aircraft features a variable camber mid–wing with leading edge extensions (LEX) mounted on each side of the fuselage from the wing roots to just forward of the windshield. The twin vertical stabilizers are angled outboard 20° from the vertical. The wings have hydraulically actuated leading edge and trailing edge flaps and ailerons. The twin rudders and differential stabilators are also hydraulically actuated. The speed brake is mounted on the top side of the aft fuselage between the vertical stabilizers. The pressurized cockpit is enclosed by an electrically operated clam shell canopy. An aircraft mounted auxiliary power unit (APU) is used to start the engines. On the ground, the APU may be used to supply air conditioning or electrical and hydraulic power to the aircraft systems.

AIRCRAFT DIMENSIONS

The approximate dimensions of the aircraft are as follows:

Span (Wing Spread)	
with missiles	40 feet 5 inches
without missile	37 feet 6 inches
Span (Wings Folded)	27 feet 6 inches
Length	56 feet
Height (To Top of Fins)	15 feet 1 inch
Height (To Top of Closed Canopy)	10 feet 6 inches

AIRPLANE GROSS WEIGHT

The following gross weights are approximate to the nearest 500 pounds. Refer to applicable DD 365F for accurate airplane weight.

General Arrangement

TYPICAL

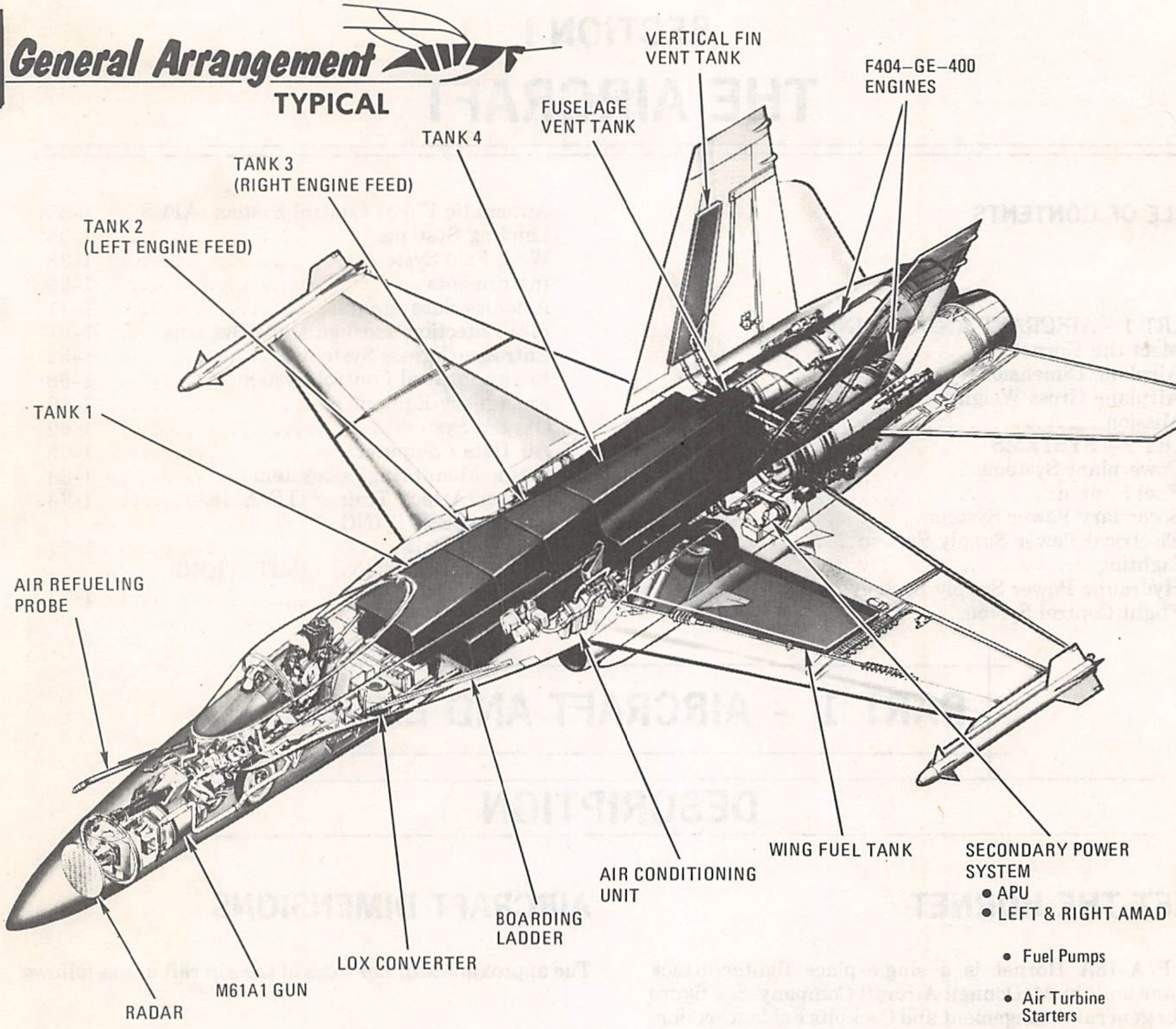


Figure 1-1. General Arrangement

Empty weight	23,500 pounds
Operating weight (empty weight plus pilot, survival equipment, nose gun, oil and unusable fuel)	24,500 pounds
Takeoff gross weight (operating weight plus full internal fuel, ammunition, (2) AIM-7 and (2) AIM-9 missiles)	37,000 pounds
Takeoff gross weight plus 3 full external fuel tanks	45,000 pounds

MISSION

The airplane has an all-weather intercept, identify, destroy and ground attack capability. Air-to-air armament normally consists of AIM-9 and AIM-7 missiles and a 20MM gun. Various air-to-ground stores may be carried. Mission range may be extended with the addition of up to 3 external fuel tanks.

PART 2 - SYSTEMS

POWERPLANT SYSTEMS

ENGINES

The airplane is powered by two General Electric F404-GE-400 engines. The engine is a low bypass axial-flow turbofan with afterburner. The 3-stage fan (low pressure compressor) is driven by a single stage turbine. Approximately one-third of the fan discharge air is bypassed to the afterburner for combustion and cooling. The 7-stage high pressure compressor is also driven by a single stage turbine. The lst and 2nd stage compressor stators are variable. Fourth stage compressor air is used by the engine anti-ice system. A set of variable inlet guide vanes are mounted in front of both the fan and compressor to direct the inlet air at the best angle for the existing engine operation. Atomized fuel and compressor discharge air is mixed and ignited in the combustion chamber. These ignited gases then pass through the compressor and fan turbines and out the engine exhaust. Afterburner operation uses added atomized fuel mixed with the combustion discharge gases and the bypass fan discharge air to produce additional thrust. The military thrust of each engine is approximately 10,700 pounds with maximum afterburner thrust in the 16,000 pound class. The aircraft thrust-to- weight ratio is in the 1 to 1 class. The electrical control assembly, variable exhaust nozzles, main fuel control, and afterburner fuel control provide coordinated operation of the engine through every part of its envelope. The engine accessory gearbox, driven by the compressor rotor, powers the lubrication and scavenge oil pumps, variable exhaust nozzle power unit, alternator, main fuel pump and control, and afterburner fuel pump and control. An airplane-mounted auxiliary power unit is used to start the engines.

AIR INDUCTION SYSTEM

The air induction system is designed to provide compatible air to the engine. The system uses a fixed geometry compression ramp, a fuselage boundary layer diverter system and a ramp boundary layer bleed system. The compressor ramp provides the correct oblique shock wave for inlet air at most Mach numbers. However, above Mach 1.75, airframe buffet and vibration due to engine inlet duct rumble may occur. The fuselage boundary layer diverter system prevents low energy air from entering the inlets. This low energy air is diverted below the fuselage. The rear part of the compression ramp is porous to prevent this boundary layer air from entering the inlet. Part of the boundary layer air is bled through a fixed area outlet into the fuselage boundary layer diverter channel. The other part exits on top of the wing through inlet duct doors, when open.

Inlet Duct Doors

The electrically operated inlet duct doors (one for each inlet) automatically open at Mach 1.33 (accelerating) and close at Mach 1.23 (decelerating). The doors are controlled by the flight control computer.

ENGINE CONTROL SYSTEM

The engine control system consists of the throttle, main fuel control, electrical control assembly (ECA) and afterburner fuel control. Throttle movement is mechanically transmitted to a power lever control. The power lever control acts as a power booster and positions the main fuel control. If the automatic throttle control is engaged, it schedules the power lever control for existing engine power requirements and the throttle follows this movement. Below MIL power, throttle movement and compressor inlet temperature (through the main fuel control) control the compressor speed (RPM). At MIL and above, fan speed is controlled by the ECA as a function of inlet temperature. At and above military power, the ECA senses engine and aircraft parameters, computes engine schedules and maintains engine limits.

NOTE

A lockup device in the main fuel control prevents thrust reduction below military if aircraft speed is Mach 1.23 or higher.

AFTERBURNER FUEL CONTROL

The afterburner fuel control schedules fuel flow to the pilot spraybar and main spraybars. When the throttle is advanced to afterburner, ignition is turned on, the exhaust nozzle opens slightly above the MIL position, the low pressure turbine discharge temperature schedule is temporarily reset to a lower value, and afterburner pilot spraybar fuel flow and minimum afterburner main fuel flow begins. When afterburner light off is detected, ignition is turned off and afterburner main fuel flow increases to the level selected by the throttle position. Since main fuel flow is withheld until a positive light off is attained, a hard light should not occur. Refer to figure 1-2 for afterburner light-off time.

IGNITION SYSTEM

The ignition system contains an independent engine mounted alternator, electrical control unit, ignition exciter, a main igniter and an afterburner igniter. During engine start, moving the throttle from OFF to IDLE turns on ignition. Ignition remains on until the engine reaches 45% rpm. Engine ignition also comes on if a flame-out occurs or when afterburner is selected. Afterburner

Afterburner Light - Off Time

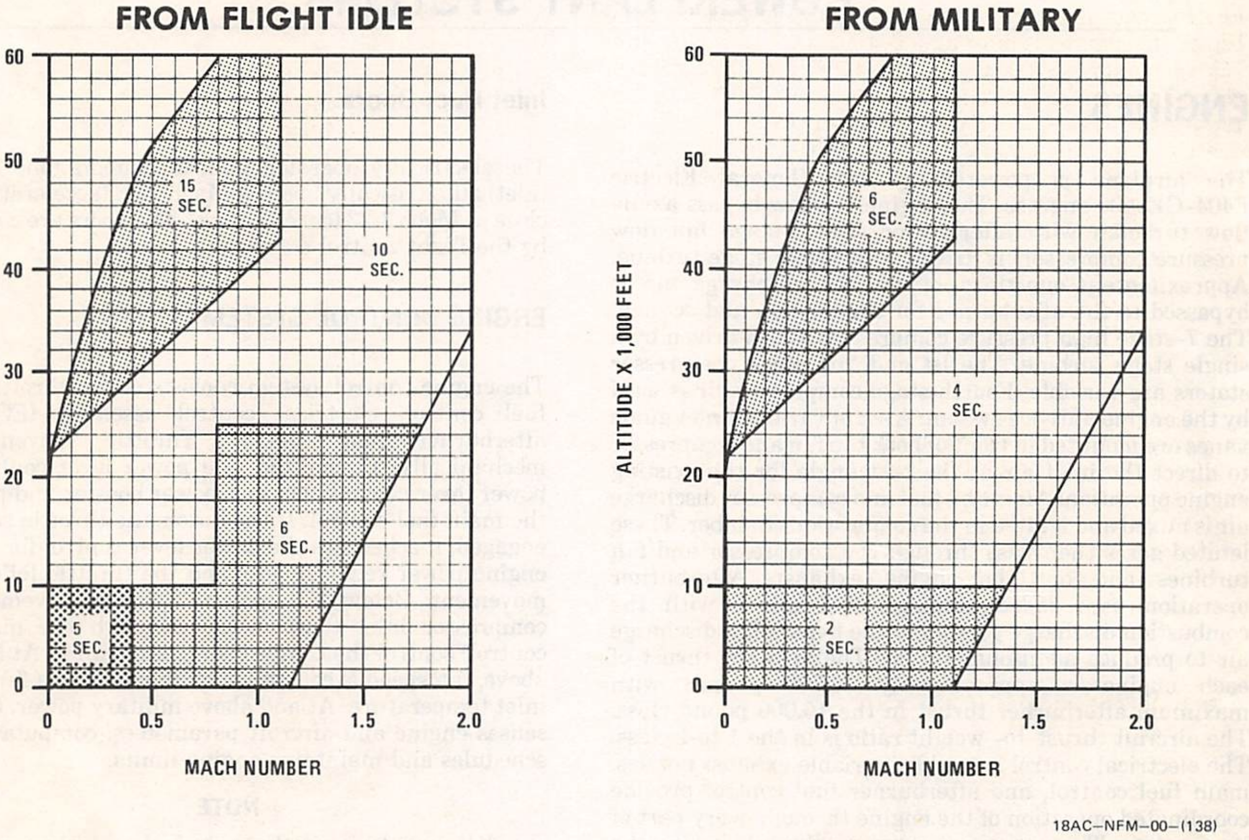


Figure 1–2. Afterburner Light–Off Time

ignition comes on when the throttle is moved into afterburner and remains on until an afterburner lightoff is sensed. If more than 50% afterburner is selected, ignition is automatically turned on if an afterburner blowout occurs.

LUBRICATION SYSTEM

The lubrication system is self–contained and consists of a pressure–filled supply tank, lubrication pump, scavenge pumps, oil filter, oil cooler, gearbox, engine sumps, scavenge screens, magnetic chip detectors, pressure transducer, pressure regulator, and interconnecting piping. Oil gravity–flows from the tank to the pump. A pressure transducer, in the pump output line, transmits an electrical signal to the cockpit pressure indicator.

ENGINE ANTI–ICE

A separate engine bleed air system, internal to the engine and from a different compressor stage than the aircraft bleed air, is used for engine anti–ice.

Engine Anti–Ice Switch

ON	Activates the engine anti–ice system.
OFF	Deactivates the engine anti–ice system.
TEST	Checks ice detector operation and turns on INLET ICE display.

ENGINE CONTROLS AND INSTRUMENTS

Engine Crank Switch

An engine crank switch is on the left console. The switch has positions of L (left), OFF and R (right). During engine start, placing the switch to L or R starts engine crank for the corresponding left or right engine. The switch is electrically held in the L or R position. As the engine accelerates to a self–sustaining rpm, the switch automatically returns to OFF. Actuation of the switch with the engine above 30% rpm may shear the air turbine starter shaft.

Throttles

Movement of the throttles is transmitted by mechanical linkage to the engine mounted power lever control torque boosters. The torque boosters are powered by environmental control system (ECS) air and convert the linear mechanical movement from the throttles into rotary motion that then moves the engine fuel control shutoff valves. The torque boosters also reduce the force required to move the throttles and interface with the flight control computer to provide automatic throttle control, when selected. A friction adjusting lever is mounted next to the right throttle. A retractable inflight IDLE stop provides a ground and inflight IDLE. With weight on the wheels, the inflight stop is retracted and the ground IDLE stop is used. With weight off the wheels, the inflight stop extends and provides a higher (inflight) IDLE rpm. Advancing the throttles from OFF to IDLE (during engine start) opens the engine fuel control shutoff valves and enables engine ignition. Finger lifts on the front of the throttles must be raised before the throttles can be returned to OFF. Moving the throttles to OFF closes the engine fuel control shutoff valves, stopping fuel flow to the engines. Afterburner operation is initiated by advancing the throttles forward of the afterburner detents. The throttle grips (figure 1-3) contain switches that provide various system controls without moving the left hand from the grips.

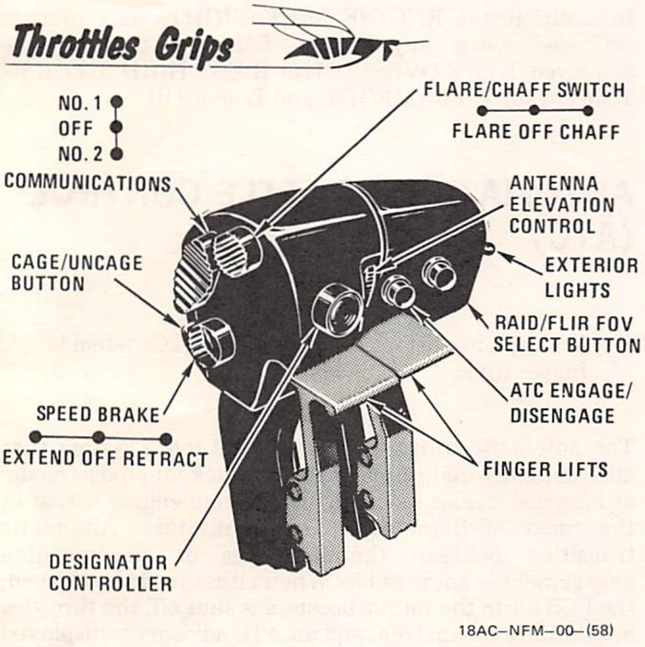


Figure 1–3. Throttle Grips

Engine Monitor Indicator (EMI)

The engine monitor indicator contains a left and right display for RPM %, EGT °C, FF PPH (fuel flow), NOZ POS % (nozzle position) and OIL PSI (oil pressure). Refer to Cockpit F/A–18A; Front Cockpit TF/A–18A in the Foldout section.

RPM %	Displays compressor rpm. Range is 0 to 110% rpm with 1% rpm increments.
EGT °C	Display turbine exhaust gas temperature (T_5). Range is 0 to 999°C with 1°C increments.
FF PPH	Displays main engine fuel flow only (afterburner fuel flow is not displayed). Range is 300 to 15,000 pounds per hour with 100 pounds per hour increments. The tens and units positions have fixed zeros. When fuel flow is less than 350 PPH, zero is displayed.
NOZ POS %	Displays nozzle position. Range is 0 to 100% with 10% increments.
OIL PSI	Displays engine oil pressure. Range is 0 to 200 psi with 10 psi increments.

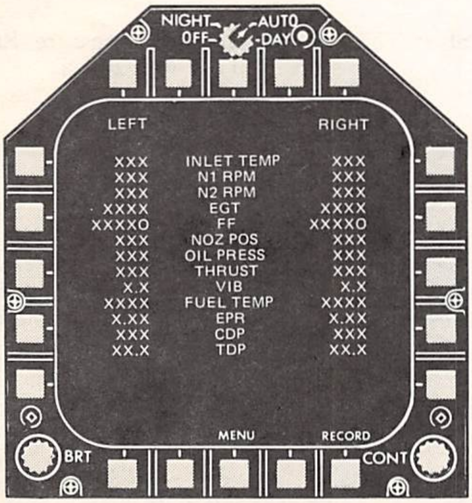
Engine Monitor Display (EMD)

The engine monitor display may be selected on either DDI by pressing MENU then pressing ENG. If a malfunction exists, pressing RECORD will assist the ground crew during trouble shooting.

INLET TEMP	Engine inlet temperature °C.
N1 RPM	Fan speed in % rpm.
N2 RPM	Compressor speed in % rpm.
EGT	Exhaust gas temperature in °C.
FF	Fuel flow in pounds per hour.
NOZ POS	Nozzle position in %.
OIL PRESS	Oil pressure in psi.
THRUST	Thrust in %.
VIB	Engine vibration in inches per second.
FUEL TEMP	Engine inlet fuel temperature °C.
EPR	Engine pressure ratio (ratio of exhaust pressure to ambient inlet pressure). On airplanes 161925 and up with weight off wheels, EPR is a ratio of exhaust pressure to ambient total inlet pressure. On all airplanes, EPR is valid only during ground static conditions.
CDP	Compressor discharge pressure in psia.

TDP	Turbine discharge pressure in psia.
RECORD	When button is pressed, existing displays are recorded on a magnetic tape.On airplanes 161925 and up, when power is first applied to the airplane, the RECORD option is not displayed until the mission computer initialization is complete. When the RECORD button is pressed and recording is in progress the RECORD display is boxed.

Engine Monitor Display (EMD)



Thrust is only displayed during ground engine runup check.

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Figure 1–4. Engine Monitor Display (EMD)

Caution and Advisory Displays

The following engine related caution and advisory displays may appear on the DDI:

	CAUTION
L or R OVRSPD	Designated fan or compressor rpm high.
L or R EGT HIGH	Either engine EGT over limit.
L or R IN TEMP	Designated engine inlet temperature is out of limits. Operation behind another aircraft's exhaust may cause a false caution.On airplanes 161925 and up, the L and R IN TEMP caution is inoperative on the ground with engine rpm below approximately 76%. However, a false caution may be displayed if rpm is above approximately 76%.
L or R FLAMEOUT Airplanes 161925 and up	Designated engine failed. To prevent false cautions the system is deactivated until after normal engine start and anytime the throttle is placed below IDLE.
INLET ICE	Icing condition in either engine inlet.
L or R DUCT DR	Designated inlet duct door closed above Mach 1.33 or open below Mach 1.23.
L or R OIL PR	Designated engine oil pressure out of limits.
L or R BOOST LO	Designated fuel boost pressure low.
	ADVISORY
L or R HEAT	Designated engine anti–ice switch ON.

In addition, the ENGINE LEFT (RIGHT) voice alert is activated when any of the following cautions are displayed: L or R OVRSPD, L or R EGT HIGH, L or R IN TEMP, L or R FLAMEOUT and L or R OIL.

AUTOMATIC THROTTLE CONTROL (ATC)

NOTE

On airplanes before 7.0 PROM, the ATC system is inoperative.

The automatic throttle control is a 2 mode system that automatically maintains angle of attack (approach mode) or airspeed (cruise mode) by modulating engine thrust in the range of flight idle through military. Automatic transition between the 2 modes or single–engine engagement is not possible. When either mode is engaged, the ECS air to the torque boosters is shut off, the throttles are initially backdriven, and an ATC advisory is displayed on the HUD. If either mode does not engage when selected, or automatically disengages after engagement, the ATC display flashes for 10 seconds and is then removed from the HUD. If a force of approximately 12 pounds (with friction off) is applied to either throttle the system automatically disengages. This force is sufficient to permit the hand to follow throttle movement without causing disengagement. If a mechanical failure occurs, a force of approximately 68 pounds (with friction off) is required to override the system. When either mode is engaged, changing the flap switch between AUTO and HALF or FULL automatically disengages the system. If the system is disengaged for any reason, it remains disengaged until reengagement is initiated by the pilot.

NOTE

Momentary force applied to the throttle(s) (throttle rap) may not disengage the ATC system. The force must be applied and held for a minimum of .25 seconds.

ATC APPROACH MODE

The APC mode is engaged by pressing and releasing the ATC button on the left throttle with the flap switch in HALF or FULL and the trailing edge flaps extended at least 27°. When ATC is engaged in the approach mode, the flight control computer modulates engine thrust to maintain on-speed AOA. The computer uses inputs of AOA, normal load factor, stabilator position, pitch rate, and angle of bank to generate command signals. These signals drive the engine mounted throttle control units which in turn command the engine fuel controls. The computer uses AOA as the primary input to generate command signals. However, normal load factor provides increased stability, stabilator position provides increased or decreased thrust for pilot induced pitch changes, pitch rate provides lead during pitch maneuvers, and bank angle provides additional thrust during banking maneuvers. Normal disengagement is accomplished by pressing the ATC button or applying and holding force to either throttle. Automatic disengagement occurs for the following reasons:

Flap AUTO up
AOA sensor failure
Two or more failures of either trailing edge flap
Trailing edge flap deflection less than 27°
ATC button fails
FCES channel 2 or 4 fails
Weight on wheels
FCS reversion to MECH or to DEL in any axis
Left and right throttle angles differ by more than 10° for more than 1 second
Bank angle exceeds 70°
Any internal system failure

ATC CRUISE MODE

The ATC cruise mode is engaged by pressing and releasing the ATC button on the left throttle with the flap switch in AUTO. When ATC is engaged in the cruise mode, the existing airspeed is used by the flight control computer to modulate engine thrust to maintain this existing airspeed. The computer uses true airspeed from the mission computer at the time of engagement to generate a command signal. This signal is then used as a reference to generate an error signal that drives the engine mounted throttle control units. Normal disengagement is accomplished by pressing the ATC button or applying and holding force to either throttle. Automatic disengagement occurs for the following reasons:

Flaps HALF or FULL
ATC button fails
FCES channel 2 or 4 fails
FCS reversion to MECH or to DEL in any axis
Left and right throttle angles differ by more than 10° for more than 1 second
Bank angle exceeds 70° (before 8.0 PROM)
ADC true airspeed failure.
Any internal system failure

FUEL SYSTEM

See Fuel System, Foldout section, for fuel system illustration. Fuel is carried internally in four interconnected fuselage tanks and two internal wing (wet) tanks. External fuel is carried in 315 or 330 gallon centerline and/or wing tanks. External tanks may be mounted on the centerline and inboard wing station pylons. All tanks may be refueled on the ground through a single pressure refueling point. Airborne, they can be refueled through the aerial refueling probe. The internal wing tanks, tank 1, and tank 4 are transfer tanks. The tanks are arranged so internal fuel gravity transfers (at a reduced rate) even if the transfer pumps fail. Regulated engine bleed air pressure transfers fuel from the external tanks and also provides a positive pressure on all internal fuel tanks. Float type fuel level control valves control fuel level during refueling of all tanks. These same fuel level control valves are used to control fuel level during transfer from the internal wing tanks, to tank 1 and tank 4. Jet level sensors are used to control the fuel level in tanks 2 and 3 (engine feed tanks) during fuel transfer from tanks 1 and 4. All internal and external fuel (except engine feed tanks) may be dumped overboard from an outlet in each vertical fin. All internal fuel tanks are vented through the vent outlets in each vertical fin. The external tanks are vented through the vent outlets in their individual tanks. A fuel quantity indicating system provides fuel quantity indications in pounds.

SURVIVABILITY

The internal fuel tanks are forward of the engines. The internal wing tanks contain foam for fire/explosion protection. The lower section of the feed tanks are self sealing for "get home" protection. Fuel lines are routed inside the tanks where possible. Fuel feed lines in the main landing gear wells are wrapped with a self-sealing protective shell.

FUEL TANK PRESSURIZATION AND VENT

The pressurization and vent system provides regulated engine bleed air pressure to all internal tanks to prevent fuel boil-off at altitude and to the external tanks for fuel transfer. The system also provides pressure relief of the fuel tanks during climbs and vacuum relief of the fuel tanks during descent if the pressurization system fails. All tanks are pressurized anytime engine bleed air pressure is available, electrical power is on, the air refueling probe is retracted, weight is off the main gear and the arresting hook handle is UP.The external tanks can be pressurized with weight on the wheels or the air refueling probe extended by placing the external tank fuel control switch(es) to OVERRIDE provided the arresting hook handle is UP. The internal tanks vent into the fuselage vent tank which in turn is vented through the vertical fin vent tanks then to outlets in each vertical fin. The vertical fin vent tanks fuel returns to the vent tank by gravity flow. Any fuel that accumulates in the vent tank is returned to tanks 2 and 3 by scavenge pumps.

Tank Pressurization Caution Display

A TANK PRESS caution display on the DDI, indicates the internal tanks are pressurized when on the ground, and indicates low internal tank pressure inflight above 20,000 feet. The caution is also displayed when the air refueling probe is extended (system depressurized).

Vent Fuel Caution Display

On airplanes 161353 thru 161357, the VENT FUEL caution display on the DDI, indicates that fuel is in the left and/or right vertical fin vent system.

External Tank Pressurization Caution Display

An EXT TANK caution display on the DDI, indicates the external tanks are pressurized with the airplane on the deck.

Internal Transfer

Normal fuel transfer is accomplished by ejector pumps powered by motive flow. The ejector pumps in the internal wing tanks automatically transfer fuel to tanks 1 and 4 when the fuel level control valves in these two tanks open. The ejector pumps in tanks 1 and 4 transfer fuel to tanks 2 and 3 (engine feed tanks) when the feed tank level sensors are uncovered and open their transfer control valves.On airplanes 161925 and up, fuel transfer from tank 4 is shut off during negative G flight. The ejector pump operates continuously when either or both airframe mounted accessory drive (AMAD) driven motive flow/boost pumps are producing motive flow pressure. After a transfer tank is empty, fuel low level/floats shut off motive flow fuel to the ejector pumps.

CG Control

On airplanes 161520 and up, tank 1 fuel transfer is automatically sequenced by the fuel quantity indicating system to control the airplane CG. The system periodically shuts off tank 1 transfer to keep tank 1 and tank 4 properly balanced. This causes tank 4 to empty with about 1300 pounds of fuel (600 pounds on TF/A-18A airplanes) in tank 1. Refer to figure 1-5.

NOTE

On airplanes with CG control, if tank 4 fuel transfer fails tank 1 will not transfer fuel until the FUEL LO caution comes on. After the FUEL LO caution comes on, tank 1 transfers fuel to both engine feed tanks until the FUEL LO caution is removed. Tank 1 fuel transfer then remains cyclic until it is empty.

CG Caution Display

On airplanes 161520 and up, a CG caution display indicates that tank 1 and tank 4 fuel is not sequencing properly. CG may be further aft than normal. Refer to Flight Characteristics, section 4. The caution will not come on if the air refuel probe is extended.

Internal Wing Tank Fuel Control Switches

An internal wing tank fuel control switch, labeled INTR WING is on the exterior lights panel.

NORM	Provides automatic fuel transfer of the internal wing tanks.
INHIBIT	Electrically closes the wing damage control valve and the wing level control valves and switches the diverter valves to the fuselage position. The closed wing damage control valve prevents normal transfer of the internal wing fuel. The closed wing level control valves prevent air refueling of the internal wing tanks. Gravity transfer allows transfer of some wing fuel at a reduced rate and quantity to tank 4. The repositioned diverter valves return recirculated fuel directly to the feed tanks.

Gravity Transfer

If any or all ejector transfer pumps fail, internal fuel transfers by gravity. The flow rate is dependent on the difference in the fuel level between tanks (head pressure) and most of the transfer fuel is available. It may require sideslip to gravity transfer internal wing tank fuel. The wing tank fuel transfers to tank 4 through gravity transfer lines. Tank 4 and tank 1 transfers to tank 3 and tank 2, respectively, through flapper valves. A nose down attitude may be required to transfer most of the lower portion of tank 4 fuel to tank 3.

External Transfer

External fuel is transferred by conditioned engine bleed air pressure.

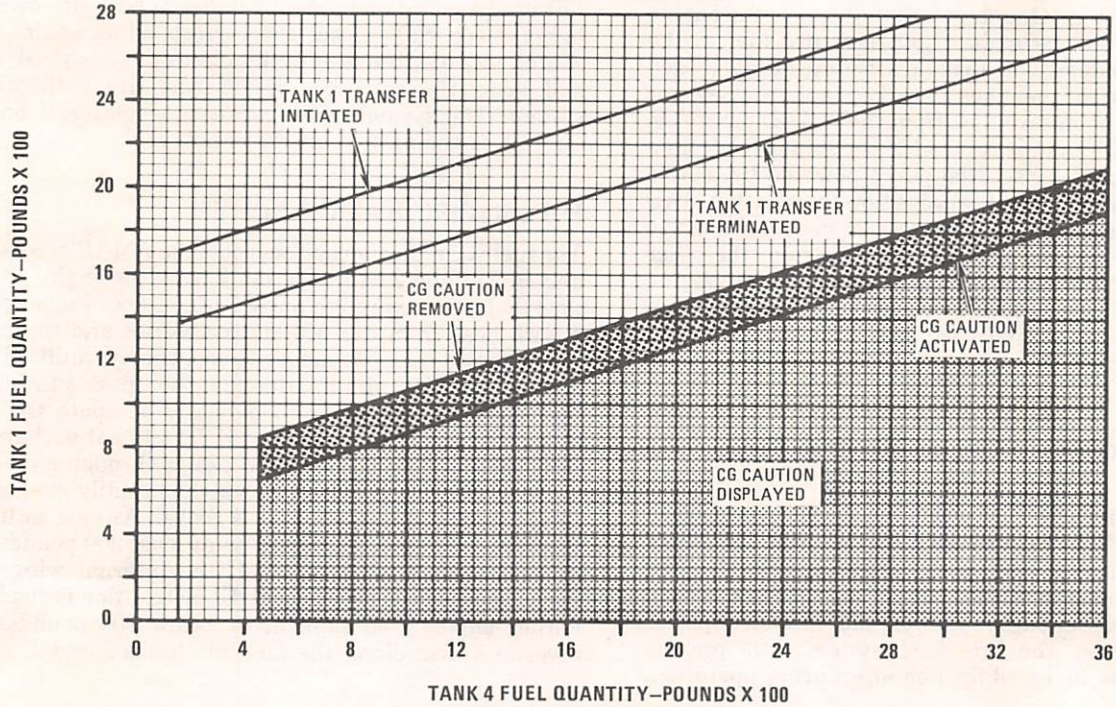
External Tank Fuel Control Switches

Two external tank fuel control switches, labeled WING (for external wing tanks) and CTR (for centerline tank), are on the fuel panel.

NORM	External fuel transfers to any internal tank that will accept it provided weight is off the main gear, the air refueling probe is retracted and the arresting hook handle is UP.
STOP	External fuel will not transfer until FUEL LO caution display is on provided the arresting hook handle is UP.
OVERRIDE	If the arresting hook handle is UP, provides fuel transfer of the external fuel regardless of air refueling probe or weight on wheels switch position.

Tank 1 and 4 Fuel C G Control and C G Caution Schedule

F/A-18A



TF/A-18A

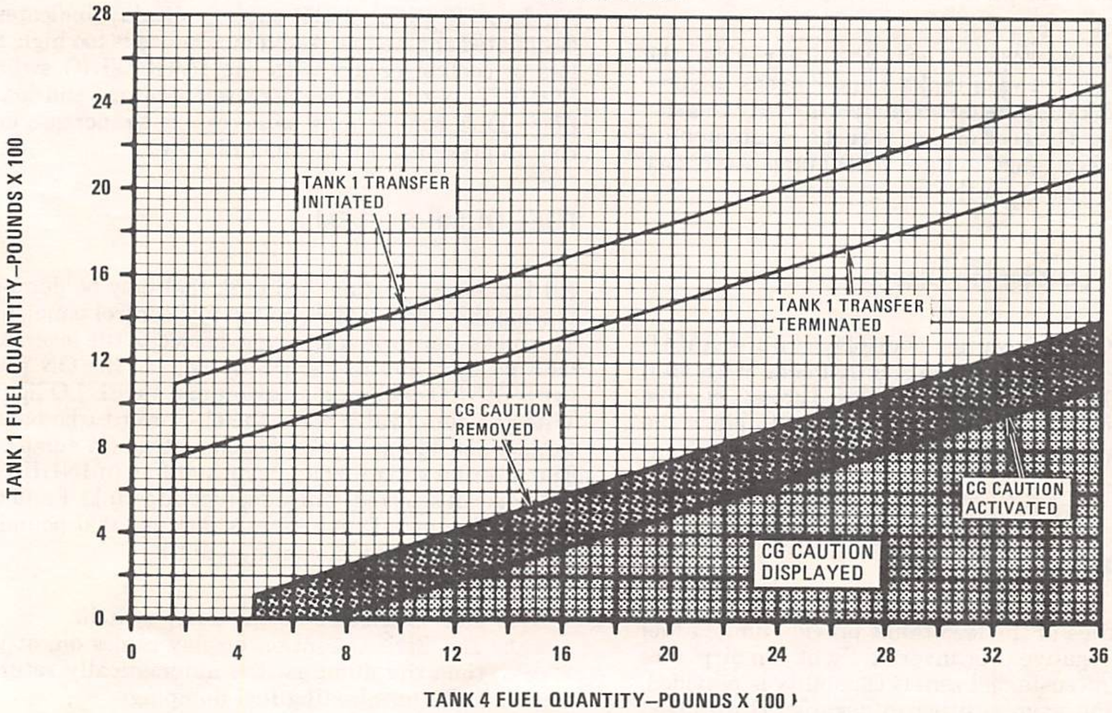


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Figure 1-5. Tank 1 and 4 Fuel CG Control and CG Caution Schedule

FUEL FEED SYSTEM

There are two separate fuel feed systems, one for each engine; however, an interconnecting crossfeed system provides fuel feed to both engines from a single fuel feed system if one system fails. An AMAD driven fuel pump provides pressurized fuel flow to each engine. Each pump is a two-stage pump. One stage supplies fuel to the engine and the other stage supplies high pressure fuel to the motive flow system. On airplanes before 161925, each AMAD pump is fed from a separate feed tank by an ejector pump powered by motive flow from the AMAD pump. On airplanes 161925 and up, each AMAD pump is fed from a separate feed tank by a turbo pump powered by motive flow from the AMAD pump. Motive flow from each AMAD pump is also used to cool the accessories on that side of the airplane and combined with motive flow from the other side to power the transfer ejector pumps. The left engine is normally fed from tank 2 by the left AMAD pump and the right engine is normally fed from tank 3 by the right AMAD pump.

Fuel Feed With Failed Ejector or Turbo Pump

If an ejector or turbo pump fails, fuel will gravity feed through the inducer inlet to the AMAD driven fuel pump. In this condition, and with high feed tank fuel temperature and high altitude flight, the fuel feed system may not supply enough fuel for the intended power setting. However, the crossfeed system will provide adequate engine fuel feed for non afterburner operation.

Fuel Feed With Loss Of Motive Pressure

If motive flow pressure is lost on either side, the interconnect valve between tanks 2 and 3 opens to allow fuel from the tank with the failed pump to gravity transfer to the other tank. The good ejector or turbo pump supplies fuel from both feed tanks to its AMAD pump. Accessory cooling is not available on the inactive side.

L or R BOOST LO Caution Display

The L or R BOOST LO caution is displayed if the AMAD pump engine feed pressure is lost on that side. With an L or R BOOST LO caution, a normally closed crossfeed valve downstream from the AMAD pumps opens to allow the good AMAD pump to feed both engines at rates sufficient for MIL power.

Negative G Baffles

Negative G baffles in the feed tanks provide limited fuel supply during negative G or inverted flight. On airplanes before 161925, no sustained zero G capability is provided. During transition from positive to negative G, the feed tank ejector valve shuttle closes at the bottom and opens at the top keeping the pump inlet submerged in fuel. Transitions may cause display of the L and/or R BOOST LO caution(s).

APU Fuel Feed

The APU receives its fuel supply from the left engine feed line upstream of the left engine feed shutoff valve.

Left and Right Fire Warning Lights

Lifting the guard and pressing either or both fire warning lights, electrically closes the corresponding engine feed shutoff valve at the feed tanks, closes the crossfeed valve and arms the corresponding engine fire extinguisher system. The system operates anytime power is on the aircraft or the battery switch is not OFF.

FUEL RECIRCULATION SYSTEM

The fuel recirculation system cools the AMAD accessories and HYD 1 and 2 hydraulic oil. Part of the engine motive flow fuel passes through an AMAD oil heat exchanger to absorb heat from the AMAD accessories and through a hydraulic oil heat exchanger to cool the hydraulic oil. On airplanes 161520 and up, this fuel then passes through a fuel air heat exchanger to partially dissipate the heat absorbed from the AMAD and HYD oil heat exchangers. This partially cooled fuel then passes through a diverter valve. Fuel from the diverter valve normally goes to the internal wing tanks where it is cooled. As long as fuel is being recirculated, there will be at least 200 pounds fuel in the internal wing tanks. If the internal wing tank switch is in INHIBIT or the FUEL LO caution is displayed (either engine feed tank at or below 800 pounds), the diverter valves direct the fuel into tanks 2 and 3.

Fuel Hot Caution Display

An L or R FUEL HOT caution display indicates the designated engine fuel feed temperature is too high. Some loss of cooling occurs with the INTR WING switch in INHIBIT. With high ambient temperature and low fuel flow (IDLE rpm) it may be necessary to increase engine rpm to prevent a FUEL HOT display.

FUEL DUMP SYSTEM

All fuel except engine feed tank fuel may be dumped by placing the dump switch, on the fuel control panel, to ON. The fuel dump switch is spring-loaded to the lever-locked OFF position and is electrically held in the ON position (with BINGO caution display off and FUEL LO light off). With the dump valve open, the ejector or turbo pumps in tanks 1 and 4 forces fuel out each vertical fin dump outlet. The internal wing fuel and external fuel (if INHIBIT and STOP is not selected) transfers fuel into tanks 1 and 4, and is then dumped. Dump rate is 600 to 1,000 pounds per minute. Dumping will continue until:

a. OFF is selected on the dump switch.
b. The BINGO caution display comes on, at which time the dump switch automatically returns to OFF, terminating fuel dumping.
c. Tanks 1 and 4 are empty.
d. Either engine feed tank fuel drops below the FUEL LO level regardless of total internal fuel quantity.

Dump Open Caution Display

A DUMP OPEN caution display indicates that the fuel dump valve is open with OFF selected.

FUEL LO LEVEL INDICATIONS

The fuel low level indicating system is completely independent of the fuel quantity indicating system. When the fuel level in either feed tank drops to 800 ±100 pounds a FUEL LO light on the caution lights panel comes on which activates the FUEL LOW voice alert, a FUEL LO caution display on the DDI appears, and the MASTER CAUTION light comes on. Once activated, the FUEL LO light and caution display will remain on for a minimum of 1 minute even though the activation was caused by a transient condition. When the fuel low warning system is activated, external fuel (if STOP has been selected) will transfer provided the arresting hook handle is UP and the diverter valves in the hot fuel recirculation system direct fuel to the engine feed tanks. Fuel dumping, if selected, will terminate.

WARNING

If the FUEL LO caution comes on, you must assume that at least one feed tank is below 800 pounds regardless of fuel gage readings.

FUEL QUANTITY INDICATING SYSTEM

The fuel quantity indicating system provides readings, in pounds, of usable internal and total fuel. See figure 1-6. The system components include the fuel quantity indicator, a built-in-test (BIT) and a BINGO caution display.

Fuel Quantity Indicator

A combination pointer-counter fuel quantity indicator is on the lower left side of the main instrument panel. The pointer indicates usable internal fuel (with readings multiplied by 1000). The counter indicates usable internal and external fuel. Two other counter positions, marked LEFT and RIGHT, and a selector switch provides individual tank monitoring and a test of the indicator. An OFF indicator is displayed if electrical power is not available. With the OFF indicator out of view, an ID flag is displayed if inputs from an intermediate device to the fuel quantity indicator are in error. False fuel indications occur during and immediately following maneuvering flight.

Fuel Quantity Selector Switch

BIT	A spring loaded position that starts built-in-test of the system.
FEED	Fuel remaining in the respective engine feed tank is displayed.
TRANS	Fuel remaining in tank 1 (LEFT) and tank 4 (RIGHT) is displayed.
INTR WING	Fuel remaining in the internal wing tanks is displayed.
EXTR WING	Fuel remaining in the external wing tanks is displayed.
EXT CRT	Fuel remaining in the centerline tank is displayed in the LEFT counter (RIGHT indicates zero).

Fuel Quantity BIT

The built-in-test system only tests the fuel quantity indicator and an intermediate device that receives signals from the individual tank sensor probes. It does not test the fuel tank sensor probes or the wiring to the intermediate device. With the fuel quantity indicator OFF flag out of view, note internal and feed tank fuel quantities. The following indications are present during BIT.

With the BINGO bug set above 6200 pounds -

a. Internal (pointer) and total (counter) indicates 6000 ±200 pounds.
b. LEFT and RIGHT (counters) indicate 600 ±50 pounds.
c. After pointer and counters reach the above values (must occur with 15 seconds), the ID flag is not in view.
d. The FUEL LO, CG (on airplanes 161520 and up) and BINGO cautions are displayed and the FUEL LO and MASTER CAUTION lights come ON. The BINGO and FUEL LOW voice alerts are activated. If the FUEL LO, CG (on airplanes 161520 and up) and BINGO cautions are not displayed within 15 seconds of BIT selection a FUEL advisory is displayed.
e. When the fuel quantity selector switch is released the pointer and counters return to their previous value, the CG (on airplanes 161520 and up) and BINGO cautions are removed and the MASTER CAUTION light goes out. The FUEL LO caution remains on for 1 minute then goes out.

Bingo Caution Display

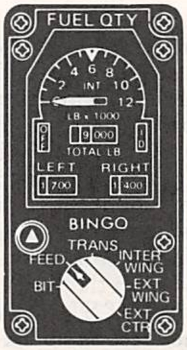
A BINGO caution display appears on the DDI at a preset value controlled by the pilot. An adjustable index (bug) on the face of the indicator may be set to any internal fuel quantity by turning the bingo knob. Fuel dumping, if selected, will terminate when the BINGO caution is displayed. The BINGO voice alert is activated when the BINGO caution comes on.

Fuel Quantity

TANK	USABLE FUEL		
	GALLONS	POUNDS JP-5	POUNDS JP-4
Number 1	418	2,840	2,720
Number 2 Left Engine Feed	263	1,790	1,710
Number 3 Right Engine Feed	206	1,400	1,340
Number 4	532	3,620	3,460
Total Fuselage	1,419	9,650	9,230
Left and Right Internal Wings	85 85 170	580 580 1,160	550 550 1,100
Total Internal	1,589	10,810	10,330

EXTERNAL TANK(S)

Elliptical Wing or Centerline Tank	314	2,140	2,040
Cylindrical Wing or Centerline Tank	330	2,240	2,150



NOTES

- The fuel quantities, in pounds, are rounded off to the nearest 10 pounds. Therefore, the actual gallons times 6.8 or 6.5 will not necessarily agree with the pounds column.
- Fuel weights are based on JP–5 or JP–4 at 6.8 or 6.5 pounds per gallon and a temperature of 15°C (59°F).

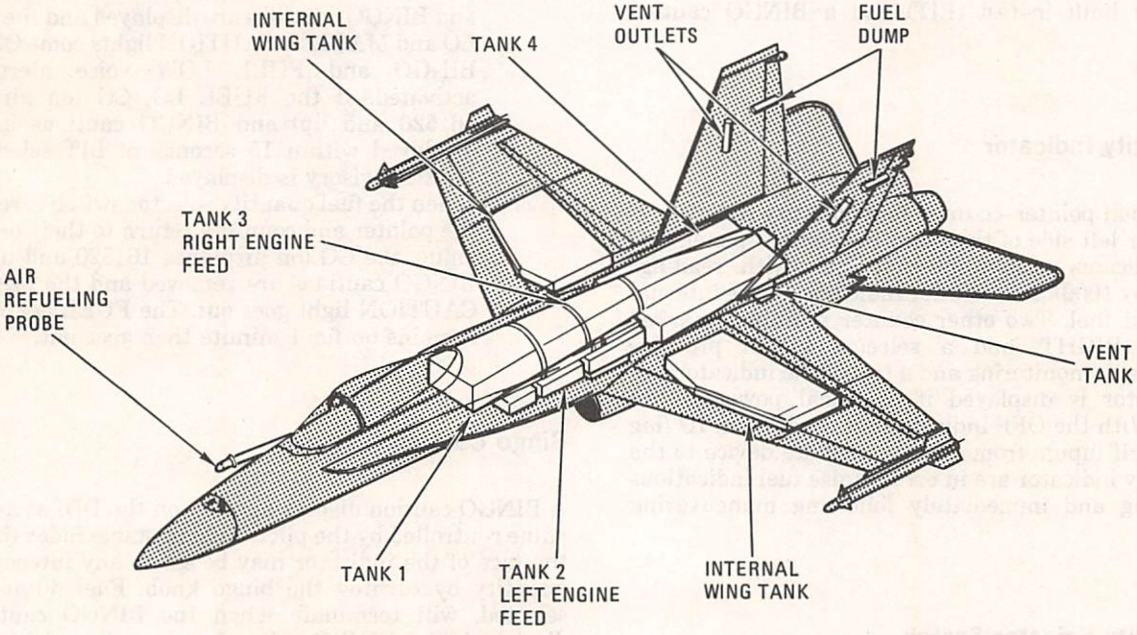


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Figure 1–6. Fuel Quantity

Fuel Advisory Display

A FUEL advisory display appears on the DDI if the FUEL LO, CG (airplanes 161520 and up) and BINGO cautions are not displayed within 15 seconds of selecting BIT with the fuel quantity selector switch.

AIR REFUELING SYSTEM

A hydraulically operated inflight refueling probe is on the right side of the fuselage forward of the windshield. The probe is extended and retracted by the HYD 2A system and controlled by a guarded PROBE switch on the fuel panel. An emergency extension system uses APU accumulator pressure to extend the probe. If the probe is not fully retracted with the control switch in RETRACT, a PROBE UNLK caution display appears on the DDI.

RETRACT	Retracts the air refueling probe and reestablishes fuel tank pressurization.
EXTD	Extends the air refueling probe, turns on the probe light, if the exterior lights master switch is on, and depressurizes the fuel tanks. The external tanks will not transfer unless their contol switches are in OVERRIDE.
EMERG EXTD	Opens the emergency air refueling probe selector valve and the APU arming valve and extends the probe with APU accumulator pressure. Retains all other functions as the EXTD position.

Internal Wing Tank Fuel Control Switch

NORM	Permits refueling and transfer of the internal wing tanks.
INHIBIT	Prevents refueling of the internal wing tanks, prevents fuel transfer from the internal wing tanks except by gravity, and diverts recirculated fuel to the engine feed tanks.

External Tank Fuel Control Switches

NORM	Permits selected external tank(s) to be refueled.
STOP	Prevents refueling of selected external tank(s).
OVERRIDE	If arresting hook handle is UP, provides transfer of selected external tank(s) during refueling.

GROUND REFUELING SYSTEM

All fuel tanks are pressure fueled through a single point receptacle. Refer to A1-F18AC-NFM-600 for ground fueling procedures.

SECONDARY POWER SYSTEM

Figure 1-7 shows the major components of the secondary power system.

AIRFRAME MOUNTED ACCESSORY DRIVE (AMAD)

There are two airframe mounted accessory drive (AMAD) gearboxes, one for each engine. Each AMAD is mechanically driven by its corresponding engine through a power transmission shaft. Either AMAD (but not both at the same time) may also be driven pneumatically through an air turbine starter (ATS) by the auxiliary power unit (APU), opposite engine bleed air (crossbleed), or an external air supply. Each AMAD mechanically drives a fuel pump, an AC generator, and a hydraulic pump.

For first engine start, the APU or external air supply drives the ATS which in turn drives the AMAD and cranks the engine. For the second engine start, the APU, external air, or crossbleed from the first engine may be used to drive the opposite ATS and crank the second engine.

For accessory drive only (maintenance use), either engine may be decoupled from the AMAD, and the APU may be used to drive the decoupled AMAD and its attached accessories. On airplanes through 161519, use of external air is not authorized.

During normal engine operation, each AMAD and its accessories are driven by the corresponding engine via the power transmission shaft. If one engine fails and the engine core is rotating freely, crossbleed or the APU may be used to keep the failed engine AMAD operating.

L and R AMAD Caution Display

The L (left) or R (right) AMAD caution display on the DDI, indicates that the corresponding AMAD oil temperature is too high.

L and R AMAD PR Caution Display

On airplanes 161925 and up, the L (left) or R (right) AMAD PR caution on the DDI, indicates that the corresponding AMAD oil pressure is low.

AUXILIARY POWER UNIT (APU)

The APU is a small aircraft mounted gas turbine engine used to generate a source of air to power the air turbine starter(s). The aircraft battery provides electrical power for the APU ignition and start control circuits. The APU uses airplane fuel. Operation of the APU is automatic after the APU switch, on the left console, is placed to ON.

Secondary Power System

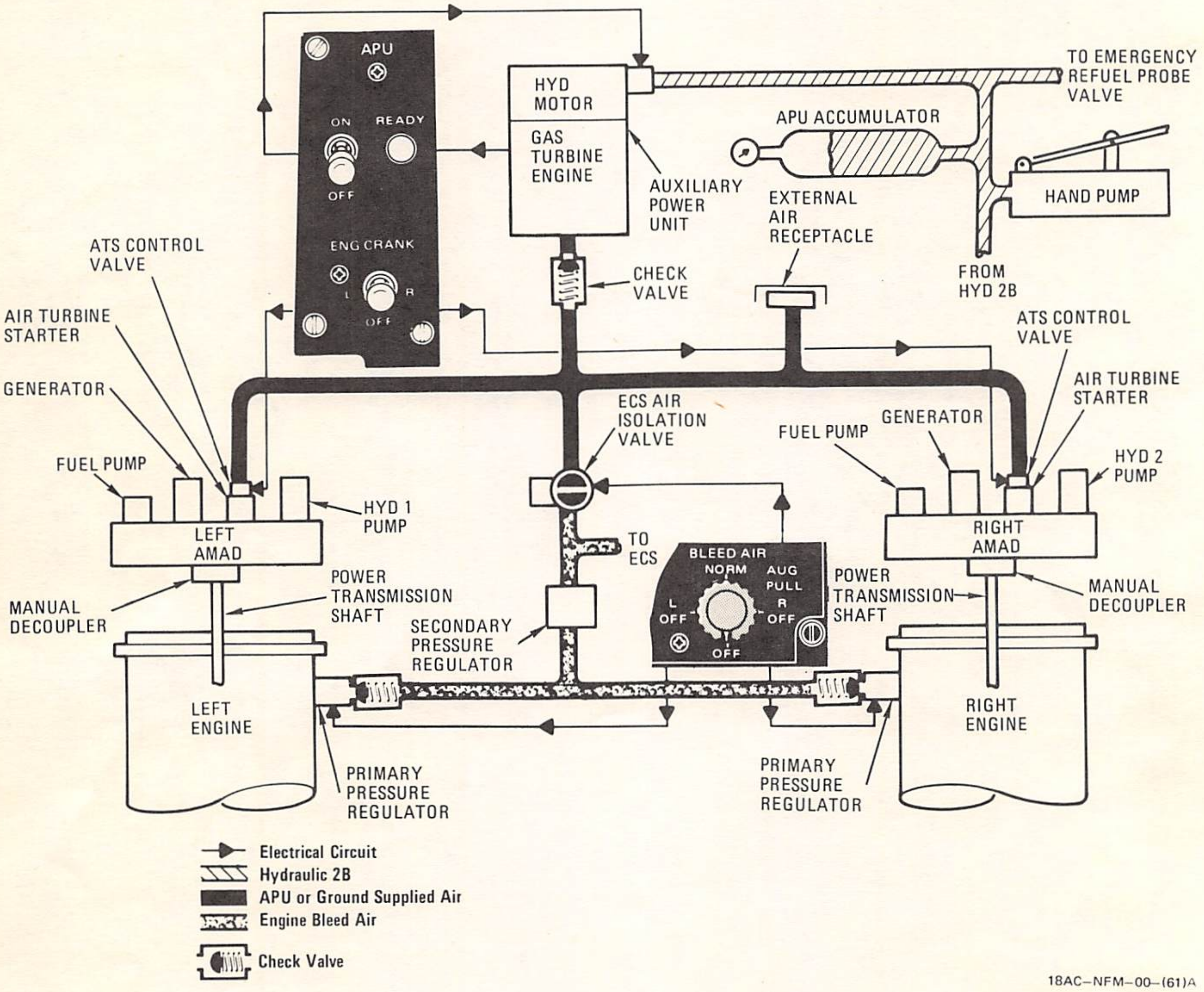


Figure 1–7. Secondary Power Supply

However, the APU may be shut down at any time by placing the APU switch to OFF. After the APU has completed its start cycle a green READY light comes on. After the second generator is on the line, the APU runs approximately 1 minute then the APU switch returns to OFF.

The APU may be used to augment the engine bleed air supply to the ECS.

A hydraulic motor powered by an accumulator, normally charged by HYD 2B is used to start the APU. A hand pump may be used to charge the accumulator.

If at least one generator is off the line, the APU may be started inflight below 10,000 feet and 250 knots.

APU ACCUM Caution Display

An APU ACCUM caution display on the DDI and caution light panel indicates the APU accumulator pressure is low. With this display, APU start, emergency gear extension, emergency extension of the air refueling probe and emergency nosewheel steering may not be available.

APU Switch

The APU switch is a two–position switch with positions of ON and OFF.

OFF	Provides a manual shutdown for the APU.
ON	Starts the start cycle of the APU. Switch is electrically held in the ON position and will automatically return to OFF 1 minute after the second generator comes on the line provided the bleed air knob is not in AUG PULL.

BLEED AIR AUGMENTATION

On the ground, the APU may be used to augment engine bleed air for ECS operation. The bleed air knob must be in any position except OFF (NORM preferred). With both generators on the line and the APU running, selecting AUG PULL overrides the APU automatic shutdown and directs APU air to the ECS to augment engine bleed air. With both generators on the line and the APU shut down, the AUG PULL position must be selected before the APU can be restarted. If the AUG PULL position is selected with only one engine operating, augmentation air is terminated during the second engine start but is regained after both engines are running. Moving both throttles to MIL or above terminates augmentation air, causes the bleed air knob to move out of the AUG PULL position and after 1 minute shuts down the APU. Pushing the bleed air knob down also terminates augmentation air and after 1 minute shuts down the APU.

START CYCLE

Both Engines From APU

Either engine may be started first; however, starting the right engine first provides normal hydraulic pressure to the brakes. After the APU READY light is on, place the electrically held engine crank switch to R. This opens the right air turbine starter control valve (ATSCV) and APU air powers the air turbine starter (ATS). The ATS in turn cranks the right engine by way of the AMAD gearbox and power transmission shaft. After the right generator comes on the line the engine crank switch automatically returns to OFF. The left engine is started the same way as the right. One minute after the second generator comes on the line the APU shuts down.

Cross Bleed From First Engine

To make a cross bleed start, the first engine should be at a minimum 80% rpm and 1900 PPH fuel flow. With the APU off, the engine crank switch controls the ATSCV and the ECS air isolation valve. Placing the engine crank switch to the second engine permits compressor bleed air from the operating engine to pass through the open ECS air isolation valve and the other ATSCV to crank the second engine. After the second generator comes on the line the engine crank switch returns to off and the ECS air isolation valve closes.

Air Turbine Starter Caution Display

An L or R ATS caution (air turbine starter) may be displayed on the DDI. The L or R ATS caution indicates the starter is turning at too high an rpm.

EXTERNAL POWER START

If the APU is not used, an external air source may be used to start the engine(s). After the bleed air knob is placed to OFF, and external air is applied in the right wheelwell, the start procdure is the same as when using the APU.

ELECTRICAL POWER SUPPLY SYSTEM

The electrical power supply system consists of two AC generators, two transformer–rectifiers, two batteries with integral battery chargers on airplanes 161353 thru 161528, or a single battery charger transformer–rectifier unit (TRU) which charges both batteries on airplanes 161702 and up, and a power distribution (bus) system. External electrical power can be applied to the bus system on the ground. In the absence of external electrical power, internal power is provided for engine starts, whether using the onboard APU or external air. See Electrical System, Foldout Section, for electrical system simplified schematics. There are two schematics, one for airplanes 161353 thru 161528 and the other for 161702 and up.

AC ELECTRICAL POWER

Two AC generators are the primary source of electrical power. The two generators are connected for split bus nonsynchronized operation. This means that with both generators operating each generator supplies power independently to certain aircraft buses. If one generator fails, it drops off the line; and at the same time, power from the remaining generator is provided to the buses of the failed (or turned off) generator. Current limiters are provided to prevent a fault in one generator system from shutting down both generators. Either generator is capable of supplying power to the entire system. Each generator is activated automatically when its control switch is in the NORM position; and the generator is connected to its buses when voltage and frequency are within prescribed limits (approximately 60% engine rpm). A protection system within the generator converter unit (GCU) protects against damage due to undervoltage, overvoltage, over and under frequency, and feeder faults.

If a fault or malfunction occurs, the generator converter unit removes the affected generator from its buses. Except for under frequency, the control switch of the affected generator must be cycled to bring the generator back on the line after the fault or out–of–tolerance condition occurs. For an under frequency condition, the generator comes back on the line automatically when in–tolerance frequency is restored. A generator may be removed from its buses at any time by placing the generator control switch to OFF.

GENERATOR CAUTION LIGHTS AND DISPLAYS

Generator caution lights, labeled L GEN and R GEN, are on the caution lights panel. These lights and the L GEN or R GEN caution display on the DDI come on whenever their respective generator drops off the line. These lights operate in conjunction with the MASTER CAUTION. In event of dual generator failure, the MASTER CAUTION light will come on (tone inoperative); however, the generator caution lights and displays will not come on.

GENERATOR CONTROL SWITCHES

Two generator control switches, one for each generator, are on the electrical power panel. They are two–position toggle switches with positions OFF and NORM.

DC ELECTRICAL POWER (AIRPLANES 161353 THRU 161528)

Two transformer–rectifiers and two batteries with integral battery chargers are provided. The output of both transformer–rectifiers are connected in parallel; however, protection is provided so that a short on a bus of one transformer–rectifier will not affect the other transformer–rectifier. If one transformer–rectifier fails, the other transformer–rectifier will power the entire DC system. No cockpit warning of single transformer–rectifier failure is provided. The batteries, designated utility or U battery, and emergency or E battery, are used for engine start when external power or airplane generator power is not available, and are used to power the essential 24/28 volt dc bus when both transformer–rectifiers are lost. The U battery also powers the maintenance 24/28 volt dc bus when both transformer–rectifiers are inoperative. This allows operation of the canopy and maintenance monitor on the ground without any other electrical power on the aircraft. The batteries are controlled by a single battery switch. The system supplies battery power to the essential bus when both transformer–rectifiers are lost and the battery switch is positioned to ON or ORIDE. With the battery switch ON, the essential bus is automatically sequenced between the two batteries. The essential bus and start bus will initially be powered by the utility battery, and as the utility battery becomes depleted the essential bus (but not the start bus) will transfer to the emergency battery. An ORIDE position is provided on the battery switch to allow selection of the emergency battery in the event the automatic sequencing system fails. In addition, the switch is provided with an OFF position to prevent depletion of the batteries while the aircraft is parked. The batteries will charge regardless of the position of the battery switch, providing power is being supplied to the battery chargers by the transformer–rectifiers. In addition, the E battery 24 volt dc bus which is connected directly to the emergency battery, and the U battery 24 volt dc bus which is connected directly to the utility battery will be powered as long as their respective battery retains a charge.

CAUTION

To prevent damage to the battery bus contactors and/or batteries do not leave the BATT switch in ON or ORIDE for extended periods without the generators on the line. After engine shutdown, ensure BATT switch is OFF and the BATT SW caution light is not ON.

BATTERY SWITCH

OFF	Batteries can be charged, but battery contactors will not energize to connect a battery to the essential bus in response to low voltage conditions.
ON	Enables control circuitry of both battery contactors, so that the U battery contactor will automatically close in response to a low voltage condition on the left 28 volt dc bus, and the E battery contactor will subsequently close in response to a low voltage condition from the U battery output and left 28 volt dc bus.
ORIDE	Position energizes E battery contactor, regardless of charge status of U battery, providing voltage on left 28 volt dc bus is absent or low. Position can be used to connect E battery to the essential buses in the event U battery contactor fails to energize with switch in the ON position.

BATTERY CAUTION LIGHTS AND DISPLAYS

Three caution lights, the U BATT, E BATT and BATT SW are associated with operation of the batteries. All three lights are displayed on both the DDI and caution lights panel. The MASTER CAUTION comes on in conjunction with these lights. The U BATT and E BATT lights come on to indicate a low state of charge of their respective batteries, and will operate only with the battery switch in the ON or ORIDE position. The BATT SW light comes on to alert the pilot to check the position of the battery switch. The light coming on, on the ground, without ac electrical power on the aircraft indicates (unless APU start about to be made) that batteries are being depleted and switch should be placed to the OFF. The BATT SW light coming on in the air normally indicates that the battery switch is in the OFF or ORIDE position and should be placed to the ON position. The BATT SW light coming on in the air with the battery switch ON indicates that the essential bus is energized by battery power (double generator or double transformer–rectifier failure) and that battery energy should be conserved.

DC ELECTRICAL POWER (AIRPLANES 161702 AND UP)

Two transformer–rectifiers and two 7.5 ampere–hour sealed lead acid batteries with a single battery charger are provided. The transformer–rectifiers are connected in parallel and protection is provided so that a short on a bus of one transformer–rectifier will not affect the other transformer–rectifier. If one transformer–rectifier fails, the other transformer–rectifier powers the entire DC system. No cockpit warning of single transformer–rectifier failure is provided. The batteries, designated utility or U battery, and emergency or E battery, are used for engine starts when external power or aircraft generator power is not available, and are used to power the essential 24/28 volt dc bus when both transformer–rectifiers are lost. The utility battery powers the U BATT/maintenance bus directly which allows operation of the canopy and maintenance monitor on the ground without any other electrical power on the aircraft. In addition, the emergency battery powers the E BATT bus directly. The E/U BATT voltmeter is used to monitor voltage on the U and E batteries. The single battery charger supplies charging power directly to the utility battery and, through the E battery charging contactor, to the E battery. The charger receives power from the right 115 volt ac bus and will provide charging power to the U battery whenever ac power is on the aircraft. For the E battery to recieve charge, the left 28 volt dc bus must be powered to energize the E battery charging contactor. The batteries are controlled by a single battery switch on the electrical power panel. The system supplies battery power to the essential bus when both transformer–rectifiers are lost and the battery switch is in ON or ORIDE. With the switch ON, the normal flight position, and the left 28 volt dc bus de–energized, the U battery automatically powers the essential and engine start 24/28 volt dc buses. When the U battery depletes to 20.5 volts or below for over 0.5 second, the E battery automatically powers the essential 24/28 volt dc bus (but not the 24/28 volt engine start bus). Placing the battery switch to ORIDE connects the E battery to the essential 24/28 volt dc bus regardless of the status of the left 28 volt dc bus or the U battery. The ORIDE position is provided to allow selection of the E battery if the automatically switching circuits associated with the ON position fail. The OFF position is provided to prevent depletion of the batteries when the airplane is parked. The batteries will charge regardless of the position of the battery switch, provided ac power is on the aircraft.

CAUTION

To prevent damage to the battery bus contactors and/or batteries do not leave the BATT switch in ON or ORIDE for extended periods without the generators on the line. After engine shutdown, ensure BATT switch is OFF and the BATT SW caution light is not ON.

BATTERY SWITCH

OFF	Batteries can be charged, but battery contactors will not energize to connect a battery to the essential bus (start bus) in response to low voltage conditions. Both voltmeters are inoperative.
ON	Enables control circuitry of both battery contactors, so that the U battery contactor will automatically close in response to a low voltage condition on the left 28 volt dc bus, and the E battery contactor will subsequently close in response to a low voltage condition from the U battery output. U and E voltmeters indicate voltage on their respective batteries.
ORIDE	Position energizes E battery contactor, regardless of status of U battery or left 28 volt dc bus. Position can be used to connect E battery to the essential buses in the event U battery contactor fails to energize with switch in ON. Only E voltmeter is operative.

E/U BATT VOLTMETER

The E/U BATT voltmeter, which combines a U battery voltmeter and E battery voltmeter in one indicator, is on the electrical power panel. Voltage is indicated in 1 volt increments from 16 to 20 volts, and in 2 volt increments from 20 to 30 volts. The scales are marked at 24 volts and 20.5 volts (the U battery voltage at which the E battery will automatically power the essential 24/28 volt dc bus). With the battery switch OFF, the voltmeters are inoperative and the indicator needles indicate 16 volts. With the battery switch ON both voltmeters are operative; with the switch in ORIDE only the E voltmeter is operative.

BATT SW CAUTION LIGHT/DISPLAY

The BATT SW caution light on the caution lights panel is associated with operation of the batteries. A BATT SW caution display on the DDI (with ac power on the aircraft) and the MASTER CAUTION comes on in conjunction with the caution light. The BATT SW comes on to alert the pilot to check the position of the battery switch. The light coming on, on the ground, without ac power on the aircraft indicates that batteries are being depleted and switch should be placed OFF unless APU start about to be made. The BATT SW light coming on in the air normally indicates that the battery switch is in OFF or ORIDE and should be placed to ON. The BATT SW light coming on in the air with the battery switch in ON indicates that the essential bus is energized by battery power (double generator or double transformer–rectifier failure) and that battery energy should be conserved.

EXTERNAL ELECTRICAL POWER

External electrical power may be connected to the aircraft bus system through an external electrical power receptacle on the left side of the forward fuselage. The aircraft buses are energized by external power in the same manner as if a generator were operating. However, some aircraft systems will not energize immediately upon application of external power. Power can be applied to these systems through actuation of ground power switches.

EXTERNAL GROUND POWER SWITCH

The external power control switch, on the ground power panel on the left console (figure 1-8) controls application of external power to the aircraft electrical buses. If the external power is not of the proper quality (within voltage, phase and frequency limits) the external power monitor senses this and disconnects or prevents the external power from being connected to the aircraft.

RESET	Switch must be positioned to RESET before external power can be applied to aircraft buses. The RESET position is spring loaded to NORM.
NORM	Allows the aircraft electrical buses to be energized by external power if no aircraft generators are operating, providing external power is of proper quality and this switch is first positioned to RESET.
OFF	Disconnects external power from the aircraft.

GROUND POWER SWITCHES

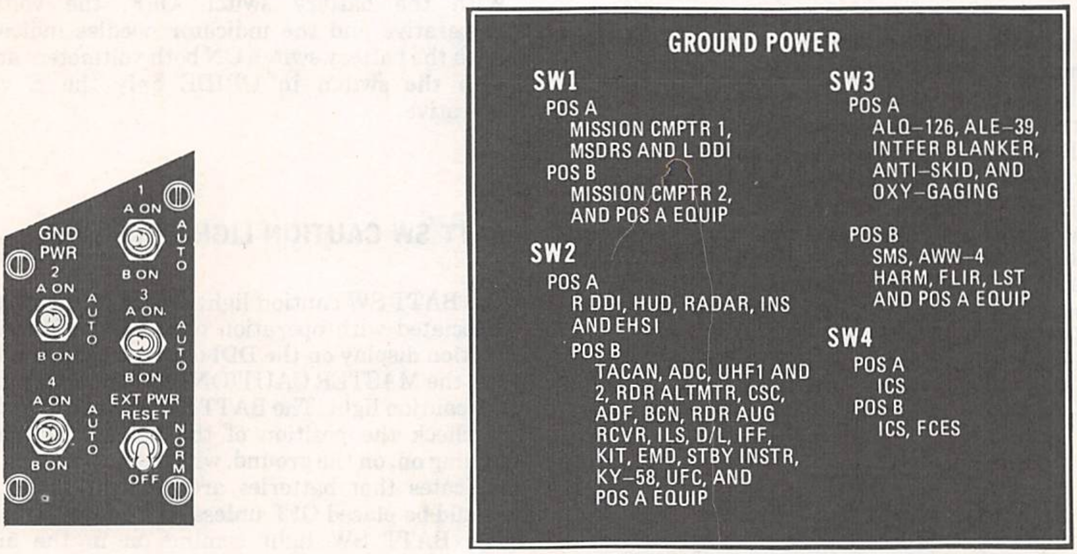
Four ground power switches are provided on the ground power panel (figure 1-8) on the left console. Each controls a group of systems and/or instruments (listing is on a placard above the panel) and will prevent operation of the systems/instruments on external power.

AUTO	System/instrument can only be energized by aircraft generator power.
ON	System/instrument can be energized by external power for maintenance purposes. When a generator comes on the line, the switch returns to AUTO.

NOTE

With an overheat condition present, all ground power switches in the ON position (solenoid held) will revert to the AUTO position, and can not be returned to ON until the overheat condition is corrected.

Ground Power Panel And Placard



GROUND POWER

SW1
POS A
MISSION CMPTR 1,
MSDRS AND L DDI
POS B
MISSION CMPTR 2,
AND POS A EQUIP

SW2
POS A
R DDI, HUD, RADAR, INS
AND EHSI
POS B
TACAN, ADC, UHF1 AND
2, RDR ALTMTR, CSC,
ADF, BCN, RDR AUG
RCVR, ILS, D/L, IFF,
KIT, EMD, STBY INSTR,
KY-58, UFC, AND
POS A EQUIP

SW3
POS A
ALQ-126, ALE-39,
INTFER BLANKER,
ANTI-SKID, AND
OXY-GAGING
POS B
SMS, AWW-4
HARM, FLIR, LST
AND POS A EQUIP

SW4
POS A
ICS
POS B
ICS, FCES

18AC-NFM-00-(41) B

Figure 1-8. Ground Power Panel & Placard

CIRCUIT BREAKERS

Two circuit breaker panels containing essential breakers are located above the right and left consoles. The panel above the left console contains the following breakers: FCS CHAN 1, FCS CHAN 2, SPD BRK and LAUNCH BAR. The panel above the right console contains the following breakers: FCS CHAN 3, FCS CHAN 4, HOOK and LG.

LIGHTING

EXTERIOR LIGHTING

Exterior lights are controlled from the exterior lights panel, the left vertical panel, and the left throttle grip.

EXTERIOR LIGHTS MASTER SWITCH

The exterior lights master switch, on the outboard left throttle grip, provides a master control for the following exterior lights: position lights, formation lights, strobe lights, arresting hook floodlight and refueling probe light.

OFF (AFT)	Power for lights controlled by switch is cut off.
ON (FWD)	Power is available for lights controlled by switch.

POSITION LIGHTS

The position lights include a white light just below the tip of the right vertical tail fin, three green lights on the right side of the aircraft and three red lights on the left side of the aircraft. The green and red lights are at the following locations on their respective sides of the aircraft: wing tip, LEX forward of the wing root, and under the wing at the aileron hinge. The position lights are controlled by the POSITION lights knob on the exterior lights panel which provides variable lighting between positions OFF and BRT. The exterior lights master switch must be ON for the position lights knob to operate.

FORMATION LIGHTS

Eight formation lights are provided. Two lights are on each wing tip and show above and below a wing tip missile when installed, two lights are on the outboard of the vertical tail fins, two lights are on the aft fuselage below the vertical tail fins, and two lights are on either side of the forward fuselage just forward of the LEX. The formation lights are controlled by the FORMATION lights control knob on the exterior lights panel which provides variable lighting between positions OFF and BRT. The exterior lights master switch must be ON for the formation lights knob to operate.

STROBE LIGHTS

Two red anti–collision strobe lights, one on each outboard vertical tail fin, are provided. The strobe lights are controlled by the STROBE lights switch on the exterior lights panel. The exterior lights master switch must be ON for the strobe lights switch to be operative.

OFF	Lights are off.
BRT	Lights illuminate at full intensity.
DIM	Lights illuminate at reduced intensity.

LANDING/TAXI LIGHT

A combination landing and taxi light is on the nose gear strut. The light is controlled by the TAXI light on the left vertical panel.

OFF	Light is off.
ON	If the landing gear handle is in DN and the landing gear is down, the light is on.

APPROACH LIGHTS/ARRESTING HOOK FLOODLIGHT

Three approach lights are on the nose gear strut. With all landing gear down and locked, and weight off the gear, the lights come on as a function of angle of attack. A green light indicates a high angle of attack, an amber light indicates optimum angle of attack and a red light indicates a low angle of attack. The operating approach light flashes if the arresting hook is not down and the HOOK BYPASS switch, on the left vertical panel, is in CARRIER. If the HOOK BYPASS switch is in FIELD, the lights will not flash. The FIELD position is solenoid held and reverts to CARRIER when the arresting hook is lowered or electrical power is shutdown after flight. An arresting hook floodlight on the left inboard landing gear door illuminates the arresting hook area when the approach lights are on, provided the exterior master lights switch is on. The approach lights are dimmed whenever the warning/caution/advisory lights are dimmed. The arresting hook floodlight cannot be dimmed.

INTERIOR LIGHTING

Except for the utility floodlight, UFC display lighting and AOA indexer lights all controls for the interior lights are on the interior lights panel on the right console.

CONSOLE LIGHTING

Integral and light panel lighting for the left and right consoles, the left vertical panel, and both cockpit circuit breaker panels are controlled by the CONSOLES knob which provides variable lighting between positions OFF and BRT.

INSTRUMENT LIGHTING

Integral and light panel lighting for the instrument panel, UFC background, right vertical panel and standby magnetic compass are controlled by the INST PNL knob which provides variable lighting between positions OFF and BRT. The strobe shoot light is disabled when the instrument light knob is not in OFF.

FLOOD/CHART LIGHTING

Eight white floodlights are provided for secondary lighting. Three console floodlights are above each console, and an instrument panel floodlight is located to either side of the instrument panel. A kneeboard light is installed on the canopy arch. The lights are controlled by the FLOOD knob and FLOOD switch. With the flood switch in the COCKPIT position, the flood knob provides variable flood and kneeboard lighting between OFF and BRT. In the CHART position, the flood knob provides variable kneeboard lighting between OFF and BRT.

UTILITY FLOOD LIGHT

A portable utility floodlight is provided and normally stowed above the right console: an alligator clip attached to the light may be used to fasten the light at various locations in the cockpit at the pilot's discretion. The light contains a knob which provides variable lighting from off to bright, and a button which when pressed causes the light to come on at full intensity. The light also contains a rotary selector for red or white lighting.

EMERGENCY INSTRUMENT LIGHT

A white emergency instrument light on the right side of the instrument panel comes on to illuminate the standby flight instruments when double generator or double transformer-rectifier failure occurs. The light comes on whenever a BATT SW caution light comes on. There is no cockpit control for the emergency instrument light.

ENGINE INSTRUMENT LIGHT

The engine instrument light is a stationary non-dimmable low intensity floodlight which provides lighting for the engine monitor indicator when the APU switch is in the ON position.

WARNING/CAUTION LIGHTS KNOB

A knob labeled WARN/CAUTION, is provided on the interior lights control panel to switch the warning/caution/advisory lights from bright intensity to the low intensity range, and then vary the brightness within the low intensity range. Warning/caution/advisory lights can be switched to the low intensity range by placing the warning/caution lights knob momentarily to RESET; providing the instrument panel knob is out of the OFF position, and either the flood knob is out of OFF but less than 70% of BRT or the flood switch is in CHART. Once in the low intensity range, the warning/caution/advisory lights can be brought back to high intensity by turning the flood knob to more than 70% of BRT, placing the flood switch to COCKPIT, turning the instrument panel knob to the OFF position, or removing and re-appyling power to the aircraft.

LIGHTS TEST SWITCH

A lights test switch, labeled LT TEST, is provided to test the warning/caution/advisory lights in addition to the AOA indexer lights. The switch only operates with AC power on the airplane.

TEST	Serviceable warning/caution/advisory lights and AOA indexer lights will come on.
OFF	The switch is spring loaded off.

HYDRAULIC POWER SUPPLY SYSTEM

Hydraulic power is supplied by two separate systems (HYD 1 and HYD 2). Each system consists of two hydraulic circuits (circuit A and circuit B). Refer to Hydraulics Systems in the foldout section. The two hydraulic systems are identical with the exception of the fluid supply line from the hydraulic system 2 reservoir assembly to the APU hydraulic hand pump. The left, or system 1, provides power to the primary flight control surface actuators exclusively. The right, or system 2, also provides power to the primary flight control actuators and additionally supplies power to the speed brake and non–flight control actuators. Redundancy to the flight control actuators is achieved either by simultaneously pressurizing the actuator from both systems or by supplying pressure to the actuator from one system while the other system is in a back–up mode.

PUMPS AND RESERVOIRS

The hydraulic pump for system 1 is mounted on the left AMAD (Airframe Mounted Accessory Drive) and the pump for system 2 is mounted on the right AMAD. The pumps contain a pressure regulating feature which keeps the pump output at approximately 3000 psi. A pressure relief valve in the filter and pressure relief valve hydraulic unit prevents over pressurization of the hydraulic system and subsystems. A transducer in each reservoir continuously relays system pressure to a hydraulic pressure indicator on the lower right main instrument panel. Each reservoir has a reservoir level sensing (RLS) system which shuts off a leaking branch circuit (HYD 1A, HYD 1B, HYD 2A, or HYD 2B) when the leak reduces the fluid level below a certain level. When the RLS shuts a branch circuit off and the circuit pressure drops below 1500 psi, a circuit pressure switch causes the MASTER CAUTION light and the appropriate HYD 1A, HYD 1B, HYD 2A or HYD 2B caution display on the DDI to come on. The A circuit shuts off when the reservoir level drops to 60% of full. The A circuit comes back on the line and the B circuit shuts off when the reservoir drops to 32% of full. The B circuit comes back on the line and no cautions are displayed when the reservoir level drops below 4% of full.

HYDRAULIC CIRCUITS

Before the output pressure, in each of the two hydraulic systems, is routed from the reservoir to subsystems, it is divided into circuit A and circuit B. Each circuit has a circuit shutoff feature to protect the other circuit from depletion due to leakage in the circuit. To prevent fluid loss due to leakage, when the landing gear is up, an isolation valve in both circuit A and circuit B of hydraulic system 2 shuts off pressure to the subsystems that are not normally utilized during flight. Circuit 2B isolation can be overridden for inflight recharging of the APU accumulator by holding the hydraulic isolate override switch to HYD ISOL ORIDE. Hydraulic system 2 also has a forward and aft priority valve to monitor demand on portions of the hydraulic system and provide priority for the flight control actuators. If demands on the system are great enough that pressure upstream of the priority valve decreases to approximately 2200 psi or less, the priority valve will completely block hydraulic flow through the valve until the demands on the system reaches a point that is within the systems capability to maintain approximately 2200 psi upstream of the priority valve. There are three hydraulic filter ΔP indicators in each main wheelwell. Two are in the aft outboard corner of the wheelwell and one is in the center of the aft bulkhead. A popped ΔP indicator indicates that the filter is clogged.

ACCUMULATORS

Two accumulators are provided in the system 2 circuitry. An auxiliary power unit (APU) accumulator and a brake accumulator. Both accumulators can be charged with a hand pump on the ground or by system 2 pump during flight. The APU accumulator serves to start the APU and to provide emergency back–up hydraulic power to refuel probe extension and nosewheel steering. The brake accumulator, in conjunction with the APU accumulator, provides emergency pressure to lock/unlock the landing gear and operate the brakes. A brake accumulator pressure gage is provided on the lower left instrument panel. Another brake accumulator pressure gage is provided in the nose wheelwell. Both gages receive the same signal from a common sensor on the brake accumulator manifold.

FLIGHT CONTROL SYSTEM

APPLICATION

The flight control system characteristics and mechanization for airplanes described in this manual varies between airplanes, and may vary on a particular airplane as a result of various modifications. While changes in characteristics and mechanization may involve structural and mechanical differences, such changes are associated with the particular Programmable Read–Only Memory (PROM) installed in the flight control computers. Figure 1–9 shows the items of interest to the pilot which are associated with each of the PROMs which may be installed. The pilot must determine the PROM (e.g., 5.3.1) installed in a particular airplane to determine the portions of the following description that apply to that airplane. The phrase "after 7.0 PROM" includes 7.0 PROM and all subsequent PROM.

PRIMARY FLIGHT CONTROLS (all airplanes)

The primary flight controls are the ailerons, twin rudders, differential leading edge flaps (after 7.0 PROM), differential trailing edge flaps and differential stabilators. See Flight Controls, Foldout section. Hydraulic actuators position the control surfaces. Stick and rudder feel are provided by spring cartridges. Although there is no aerodynamic feedback to the stick and rudder pedals, the effect is simulated by the flight control computers scheduling of control surface deflection versus pilot input as a function of flight conditions. Normally, inputs to the hydraulic actuators are provided by the two flight control computers (FCC A and FCC B) through the full authority control augmentation system (CAS). A direct electrical link (DEL) automatically backs up the CAS. DEL is normally a digital system but has an analog mode for backup aileron and rudder control. If digital DEL fails, a mechanical link (MECH) automatically provides roll and pitch control through a direct mechanical input from the stick to the stabilator actuators. MECH bypasses both flight control computers and the stabilator actuator servo valves. Multiple redundant paths ensure that single failures have no effect and multiple failures have minimum effect on control. Figure 1–10 shows the redundancies and the inputs used to provide the desired flight characteristics.

HYDRAULIC POWER (all airplanes)

Hydraulic power is supplied by HYD 1 and HYD 2 to all primary flight control actuators (see Hydraulic Systems diagram in foldout section). Failure of either HYD 1 or HYD 2 will not affect flight control. The system is arranged to minimize the probability of loss of control to any surface or the loss of control of one surface due to catastrophic damage to the lines or actuator powering any other surface.

PILOT CONTROLS

Flap Switch (5.3.1 PROM)

The flap switch selects which of the three flight control computer modes (auto flap up, takeoff, land) is active and thus determines the flight characteristics for those conditions.

AUTO	With the landing gear up, flight control computers are in the auto flap up mode. With the landing gear down, flight control computers are in the auto flap up mode above 215 knots accelerating or 205 knots decelerating.
HALF	Flight control computers are in the takeoff mode up to 215 knots accelerating or below 205 knots decelerating. Flight control computers are in the auto flap up mode above 215 knots accelerating or 205 knots decelerating.
FULL	Flight control computers are in the land mode up to 170 knots accelerating or below 165 knots decelerating. Flight control computers are in the takeoff mode from 170 to 215 knots accelerating or 205 to 165 knots decelerating. Flight control computers are in the auto flap up mode above 215 knots accelerating or 205 knots decelerating.

Flap Switch (After 7.0 PROM)

The flap switch selects which of the two flight control computer modes (auto flap up or takeoff and land) is active and thus determines the flight characteristics for those conditions.

AUTO	Flight controls in auto flap up mode.
HALF	Flight controls in takeoff and land mode below 250 knots. Flight controls in auto flap up mode above 250 knots.
FULL	Flight controls in takeoff and land mode below 250 knots. Flight controls in auto flap up mode above 250 knots.

PROM Applications

ITEM	PROM	
	5.3.1	AFTER 7.0
Improved roll rate	X	X
Differential trailing edge flaps	X	X
Differential leading edge flaps		X
Spin recovery switch	X	X
Stick force sensors	X	
Stick position sensors		X
Gain switch		X
Automatic flight control system		X
Automatic throttle		X
Automatic carrier landing system		X
Data link couple		X
Improved FCS cautions		X

18AC–NFM–00–(107)A

Figure 1-9. PROM Application

Control Stick (5.3.1 PROM)

A stick grip and a box containing the stick force sensors are mounted atop the stick (see figure 1–11). The stick grip contains the pitch and roll trim switch, sensor control switch, air–to–ground weapon release button, gun/missile trigger, air–to–air weapon select switch, and the undesignate/nosewheel steering button. An autopilot/nosewheel steering disengage lever (paddle switch) is mounted on the stick sensor box. When a force is applied to the stick grip, it is sensed by the stick force sensors which transmit a proportional electrical signal to the flight control computers. It is not necessary that the stick move to accomplish this although it will, normally, move proportional to the applied force. In TF/A aircraft, pilot input can be cancelled if rear cockpit stick grip force is opposite to the pilot's input. This can occur as a result of rear crewmember input or if rear cockpit stick grip movement is obstructed. In pitch, a combination of full nose–up and full nose–down inputs will cause a nose–up pitch rate about 1/3 of the normal full nose–up pitch rate. In roll, a combination of full left and full right will cancel each other.

Control Stick (after 7.0 PROM)

The stick grip contains the pitch and roll trim switch, sensor control switch, air–to–ground weapon release button, gun/missile trigger, air–to–air weapon select switch, and the undesignate/nosewheel steering button An autopilot/nosewheel steering disengage switch (paddle switch) is mounted below the stick grip (see figure 1–11). Stick position sensors transmit an electrical signal proportional to stick displacement from neutral to the flight control computers.

Rudder Pedals (all airplanes)

Movement of the rudder pedals transmits a proportional electrical signal to the flight control computers. The rudder pedals are also used for nosewheel steering and brakes. In TF/A aircraft, rear cockpit pedal input can cancel pilot input.

Rudder Pedal Adjust Lever (all airplanes)

Pressing the rudder pedal adjust lever on the main instrument panel releases the rudder pedals. Both pedals are then forced aft by springs and pushed forward by the pilot to the desired position. Releasing the lever locks the rudder pedals in the new position.

Pitch and Roll Trim Switch (all airplanes)

Normally, movement of the pitch and roll trim switch electrically biases the flight control computers and the stick will not move. Little if any pitch trim is required in the auto flap up mode due to the automatic trimming functions within the flight control computers. In MECH, pitch trimming changes the stick neutral position.

Rudder Trim Knob (all airplanes)

Movement of the rudder trim knob on the FCS control panel electrically biases the flight control computers. The rudder pedals will not move.

T/O Trim Button (all airplanes)

The T/O trim button is in the center of the rudder trim knob on the FCS panel. With weight on wheels holding the button pressed drives the pitch, roll, and yaw trim to the takeoff position and zeros the MECH stick position. When the control surfaces are trimmed for takeoff, TRIM advisory is displayed on the DDI until the button is released. In flight, pressing the T/O trim button only neutralizes the MECH stick position.

FCS RESET Button (all airplanes)

The FCS RESET button on the FCS panel is used to reset the flight control computers after a transient malfunction. On aircraft with 5.3.1 PROM, hold the FCS RESET button pressed for at least ½ second to ensure a complete reset.

Gain Switch (5.3.1 PROM)

The gain switch is inoperative and lockwired in the NORM position.

Flight Control System Functional Diagram

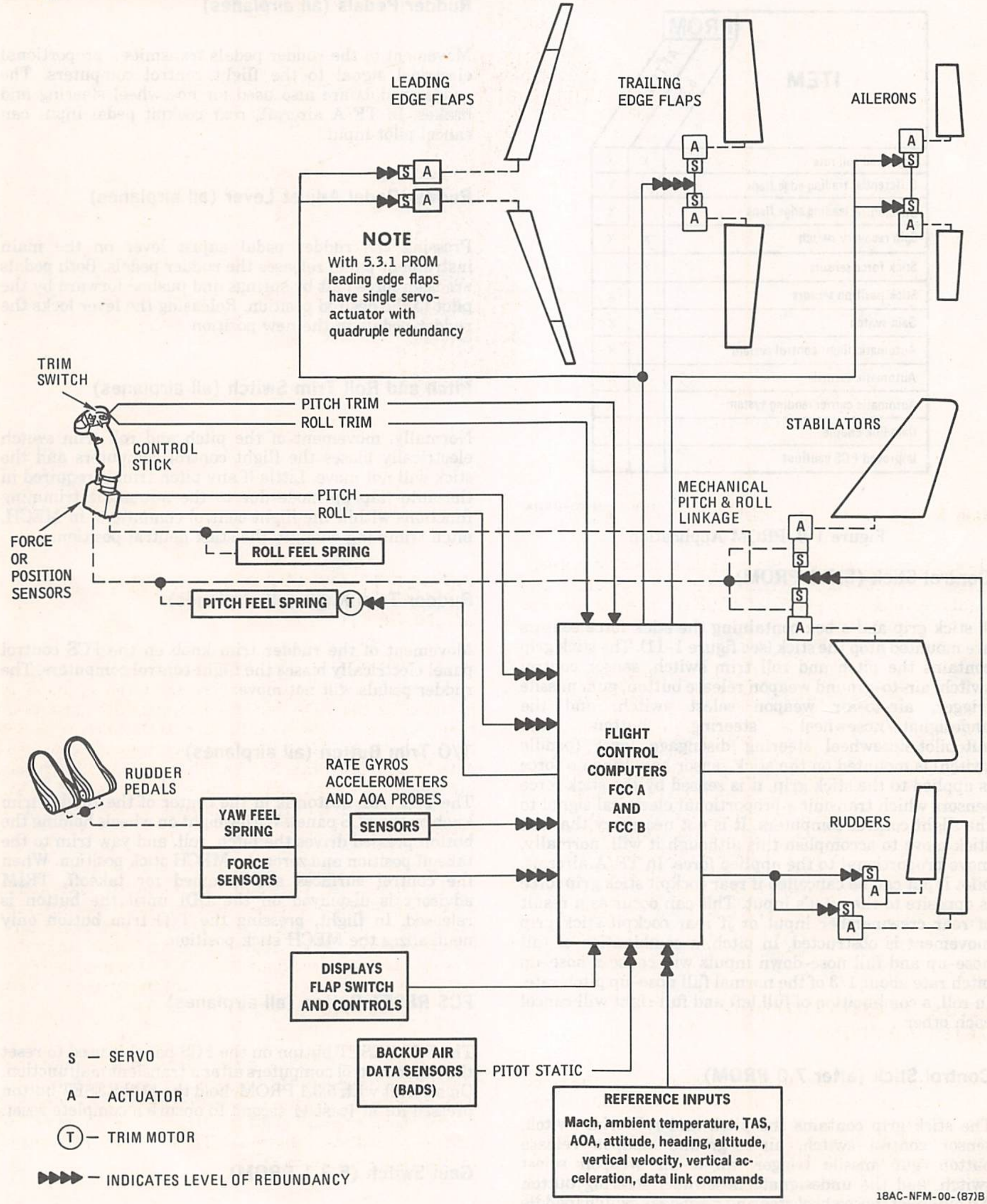

LEADING EDGE FLAPS
TRAILING EDGE FLAPS
AILERONS
S
A
NOTE
With 5.3.1 PROM leading edge flaps have single servo-actuator with quadruple redundancy
TRIM SWITCH
PITCH TRIM
ROLL TRIM
CONTROL STICK
STABILATORS
PITCH
ROLL
MECHANICAL PITCH & ROLL LINKAGE
FORCE OR POSITION SENSORS
ROLL FEEL SPRING
PITCH FEEL SPRING
T
FLIGHT CONTROL COMPUTERS FCC A AND FCC B
RUDDER PEDALS
RATE GYROS ACCELEROMETERS AND AOA PROBES
YAW FEEL SPRING
SENSORS
FORCE SENSORS
RUDDERS
DISPLAYS FLAP SWITCH AND CONTROLS
BACKUP AIR DATA SENSORS (BADS)
PITOT STATIC
REFERENCE INPUTS
Mach, ambient temperature, TAS, AOA, attitude, heading, altitude, vertical velocity, vertical acceleration, data link commands
S — SERVO
A — ACTUATOR
T — TRIM MOTOR
▶▶▶▶ — INDICATES LEVEL OF REDUNDANCY
18AC-NFM-00-(87)B

Figure 1–10. Flight Control System Functional Diagram

Control Stick

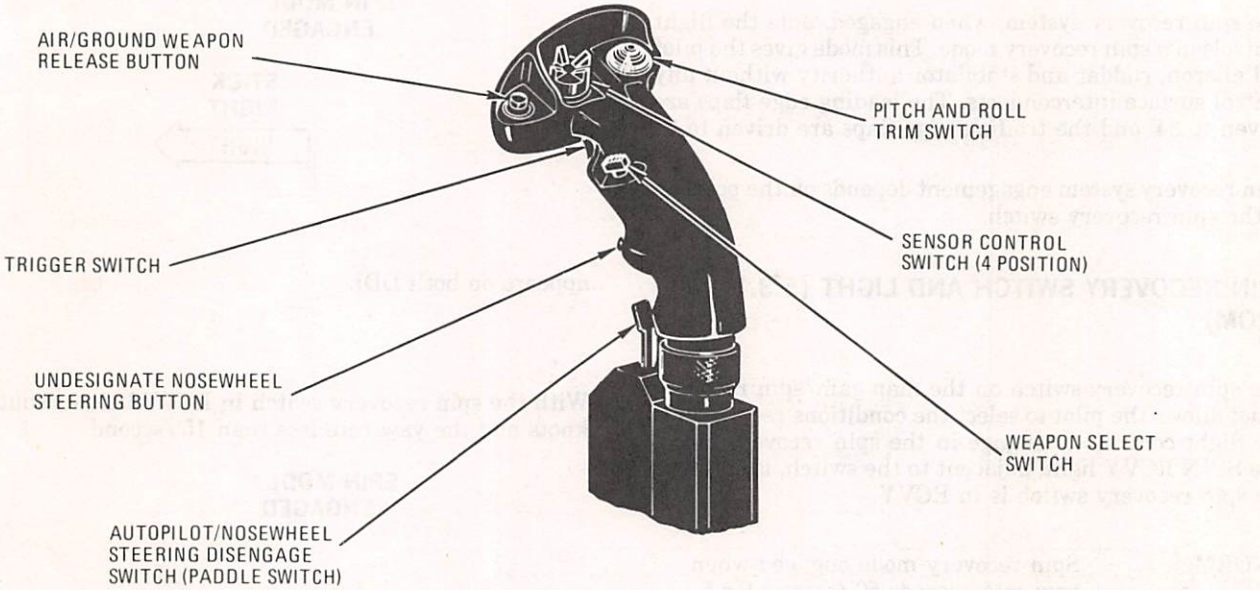

AIR/GROUND WEAPON RELEASE BUTTON
PITCH AND ROLL TRIM SWITCH
TRIGGER SWITCH
SENSOR CONTROL SWITCH (4 POSITION)
UNDESIGNATE NOSEWHEEL STEERING BUTTON
WEAPON SELECT SWITCH
AUTOPILOT/NOSEWHEEL STEERING DISENGAGE SWITCH (PADDLE SWITCH)
18AC–NFM–00–(42)

Figure 1–11. Control Stick

Gain Switch (after 7.0 PROM)

The Gain switch on the FCS panel allows the pilot to select a fixed value for speed, altitude, and AOA inputs to the flight control computers. The ORIDE position disables the spin recovery system.

NORM	Actual values for airspeed and altitude used for FCC calculations.
ORIDE	With flap switch AUTO, CRUIS advisory on DDI and flight control schedules optimized for Mach 0.7 and 2° AOA at 35,000 feet. Slow below 350 knots and reduce AOA below 10° before selecting ORIDE. With flap switch HALF or FULL, LAND advisory on DDI and flight control schedules optimized for 133 knots and 8.1° AOA at sea level. Do not select HALF or FULL above 250 knots.

ACTUATOR EXERCISER MODE (AFTER 7.0 PROM)

On airplanes after 7.0 PROM, an actuator exerciser mode is incorporated to improve cold weather start–up of the FCS. On the ground, the pilot can initiate the exerciser mode by simultaneously holding the FCS BIT switch ON and pressing the FCS RESET. When initiated, the mode cycles the stabilators, flaps, ailerons, and rudders through 20% of full travel for 10 cycles in 20 seconds. The operation can be stopped before 20 seconds have elapsed by pressing the paddle switch. The mode should be used in cold weather or any time an initial FCS RESET fails.

DEPARTURE WARNING TONE (all airplanes)

With 5.3.1 PROM, and the FCC in the takeoff or landing mode, an audio departure warning tone (beeping sound) is initiated as the AOA increases through 15°. The beep frequencey increases with further AOA increase to 35° AOA. Above 35° AOA, the frequency remains constant. After 7.0 PROM, with flap switch in FULL, the tone is initiated at 12° AOA and becomes constant at 32° AOA; with flap switch in HALF, the tone starts at 15° and becomes constant at 35°.

With the FCC in the auto flap up mode, the audio departure warning tone is initiated at 25°/second yaw rate. The beep frequency increases with yaw rate up to 45°/second yaw rate. Above 45°/second yaw rate, the frequency remains constant. Above 35° AOA and below –7° AOA, the tone comes on at a constant frequency and yaw rate warning is no longer available.

On airplanes with wing pylon mounted air–to–ground stores or tanks code set in the armament computer and the rack hooks for those stores closed, a steady tone is heard at and above 20° AOA (5.3.1 PROM) or 25° AOA (after 7.0 PROM) regardless of flap mode. The tone does not occur if all stores are shown as HUNG.

The departure warning tone does not operate on the ground.

SPIN RECOVERY SYSTEM (all airplanes)

The spin recovery system, when engaged, puts the flight controls in a spin recovery mode. This mode gives the pilot full aileron, rudder and stabilator authority without any control surface interconnects. The leading edge flaps are driven to 34° and the trailing edge flaps are driven to 0°.

Spin recovery system engagement depends on the position of the spin recovery switch.

SPIN RECOVERY SWITCH AND LIGHT (5.3.1 PROM)

The spin recovery switch on the map gain/spin recovery panel allows the pilot to select the conditions required for the flight controls to engage in the spin recovery mode. The SPIN RCVY light, adjacent to the switch, is on when the spin recovery switch is in RCVY.

NORM	Spin recovery mode engaged when yaw rate exceeds 50°/second for 5 seconds. The flight controls will revert to normal schedules when the yaw rate drops below 30°/second.
RCVY	With the flaps in the auto flap up mode (gear up and flap switch AUTO), spin recovery mode engaged when airspeed decreases below about 155 knots. Both DDI displays are replaced by the spin recovery display. The flight controls revert to normal schedules when airspeed increases above about 155 knots and yaw rate is less than 15°/second.

DDI SPIN RECOVERY DISPLAYS (5.3.1 PROM)

With the spin recovery switch in RCVY and the flight controls not in the spin recovery mode,

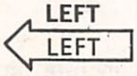
SPIN MODE

appears on both DDI, replacing the previous displays.

With the flight controls in the spin recovery mode and left yaw rate over 15°/second with positive AOA or right yaw rate over 15°/second with negative AOA

SPIN MODE
ENGAGED

STICK
LEFT

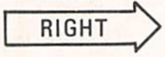


appears on both DDI.

With the flight controls in the spin recovery mode and right yaw rate over 15°/second with positive AOA or left yaw rate over 15°/second with negative AOA

SPIN MODE
ENGAGED

STICK
RIGHT



appears on both DDI.

With the spin recovery switch in RCVY below about 155 knots and the yaw rate less than 15°/second

SPIN MODE
ENGAGED

appears on both DDI.

With the spin recovery switch in RCVY and airspeed above about 155 knots, the flight controls revert to the normal mode.

SPIN MODE

appears on both DDI.

After the spin recovery switch is placed to RCVY, MENU can be used to select any desired display on either DDI to replace the spin recovery display.

If the spin recovery switch is in NORM and yaw rate less than 30°/second, the flight controls revert to the normal mode and the spin recovery display will be replaced by the MENU display.

SPIN RECOVERY SWITCH AND LIGHT (AFTER 7.0 PROM)

The spin recovery switch on the map gain/spin recovery panel allows the pilot to select the conditions required for the flight controls to engage in the spin recovery mode. The SPIN RCVY light, adjacent to the switch, is on when the spin recovery switch in in RCVY.

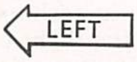
NORM	Spin recovery mode engaged when all of the following conditions are met: 1. Airspeed below about 125 knots. 2. Yaw rate over 15°/second. Engagement is delayed 15 seconds at a 15°/second yaw rate decreasing to a 5 second delay at a yaw rate of 50°/second 3. Stick is placed in the direction indicated on the DDI spin recovery display. The flight controls revert to normal schedules anytime the stick is placed in the wrong direction, the airspeed increases above about 245 knots, or the yaw rate decreases to less than 15°/second.
RCVY	Spin mode engaged when airspeed below about 125 knots. Flight controls revert to normal schedules when the airspeed increases above about 245 knots. Prospin controls can be applied with the switch in RCVY.

DDI SPIN RECOVERY DISPLAYS (AFTER 7.0 PROM)

Spin Recovery Switch in NORM

With the airspeed below about 125 knots and a left yaw rate over 15°/second with positive AOA or right yaw rate over 15°/second with negative AOA

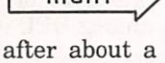
SPIN MODE
STICK LEFT



appears on both DDI after about a 15 second delay at 15°/second yaw rate decreasing to about a 5 second delay at 50°/second yaw rate.

With the airspeed below about 125 knots and a right yaw rate over 15°/second with positive AOA or left yaw rate over 15°/second with negative AOA

SPIN MODE
STICK RIGHT



appears on both DDI after about a 15 second delay at 15°/second yaw rate decreasing to about a 5 second delay at 50°/second yaw rate.

When the stick is placed in the indicated directions, the words

SPIN MODE

are replaced by

SPIN MODE
ENGAGED

When the yaw rate decreases below 15°/second or the airspeed increases above about 245 knots, the spin recovery display is replaced by the MENU display.

Spin Recovery Switch in RCVY

When the spin recovery switch is placed to RCVY

SPIN MODE

appears on both DDI.

If the airspeed decreases below about 125 knots, the words

SPIN MODE

are replaced by

SPIN MODE
ENGAGED

If a right or left yaw rate over 15°/second develops the words **STICK RIGHT** or **STICK LEFT** with an accompanying arrow will also appear on the DDI.

When the airspeed increases above about 245 knots

SPIN MODE

will appear on the DDI.

FLIGHT CONTROL COMPUTERS (FCC) (all airplanes)

Two flight control computers (FCC A and FCC B) provide the computations which determine the flight characteristics. Electrical signals generated by force applied to the stick grip (stick movement with 6.0 PROM) and rudder pedals are transmitted (each signal on 4 different channels) to both FCC. The computers use the pilot inputs and inputs from various aircraft and internal sensors to determine proper outputs to the control actuators for desired aircraft response. The multiple channel inputs and outputs are continuously monitored by the FCC for agreement. When there is disagreement, the erroneous signal is discarded or, if this cannot be determined, the control system is automatically switched to a degraded mode which does not use that signal. For survivability, one channel from each computer is routed through the upper part of the aircraft and the other channel is routed through the lower part. The stabilator and before 7.0 PROM, flap actuator servos receive 4 channel signals from the FCC. The aileron, rudder, and, after 7.0 PROM, leading edge flap servos receive 2 channel signals. FCC A is powered by the essential 28 volt dc bus. FCC B is powered by the right 28 volt dc bus. Both computers are normally cooled by avionics air but ram air can be selected for FCC A cooling.

FCS HOT Caution (all airplanes)

The FCS HOT caution light and FCS HOT caution on the DDI indicates an overtemperature in FCC A or the right transformer–rectifier.

FCS COOL Switch (all airplanes)

NORM	Both FCC and both transformer –rectifiers cooled by avionics air.
EMERG	FCC A and right transformer –rectifier cooled by ram air. FCC B and left transformer–rectifier cooled by avionics air. Once EMERG selected, selection of NORM will not switch FCC A and right transformer–rectifier cooling back to avionics air.

FCC Circuit Breakers (all airplanes)

FCS channel 1 and channel 2 (FCC A) circuit breakers are on the left essential circuit breaker panel under the left canopy rail. FCS channels 3 and 4 (FCC B) circuit breakers are on the right essential circuit breaker panel under the right canopy rail.

CONTROL AUGMENTATION SYSTEM (CAS) (all airplanes)

The longitudinal control system uses air data scheduled pitch rate, normal acceleration (N_Z) and angle–of–attack (AOA) to compute stabilator actuator commands. The aircraft response is compared to the pilot command and the stabilator servoactuator is driven to reduce the difference to zero. Since, in the auto flaps up mode, any uncommanded pitch rate or G is reduced to zero, the aircraft is constantly trimmed to steady state hands–off 1 G flight and there is little or no occasion for manual trim. Pitch rate and G (N_Z) feedbacks improve pitch characteristics and G control at medium to high airspeeds. Air data scheduled pitch rate feedback improves maneuvering characteristics and provides increasing stick–force–per–G at low to medium airspeeds. AOA feedback provides increasing stick force with increasing AOA above 15°. (5.3.1 PROM) 22° (after 7.0 PROM). In the takeoff and land modes, AOA and pitch rate feedbacks are used to augment inherent airframe pitch damping and stability. The computer nulls the difference between the trim AOA and actual AOA. In turns, pitch rate feedback maintains tight pitch attitude control.

The lateral control system uses ailerons, differential trailing edge flaps, differential leading edge flaps after 7.0 PROM, differential stabilator, and rudders to achieve the desired roll characteristics. Scheduled air data roll rate feedback is used to augment inherent airframe roll damping. At high airspeeds, aileron travel versus stick force is reduced and, with 5.3.1 PROM, then reversed and increased with increasing airspeed to prevent roll reversal due to wing aeroelasticity. After 7.0 PROM, ailerons do not deflect above 600 knots. Differential stabilator and differential trailing edge flap travel is reduced at high speed to prevent exceeding structural limits. After 7.0 PROM, the leading edge flaps deflect differentially up to ±3° above 450 knots below 10,000 feet. Differential flaps are not used in the takeoff or land modes nor above 10° AOA in the auto flaps up mode. At low airspeeds, aileron and differential stabilator travel are reduced with increasing AOA to minimize adverse yaw. Differential stabilator may also be limited due to a pitch command which has priority. With lateral stick deflection, the rolling–surface–to–rudder interconnect (RSRI) schedules increasing rudder deflection as a function of decreasing airspeed and increasing AOA for roll control, coordination, and to reduce adverse yaw. With wing pylon mounted air–to–ground stores or tanks code set in the armament computer and the rack hooks for those stores closed, maximum roll rate is automatically reduced about 33%. If all stores are shown as HUNG, roll rate limiting is removed; however, a NO LIMITER caution will appear on the DDI.

The directional control system uses twin rudders for yaw control. The FCS nulls yaw rate to provide yaw damping. Lateral acceleration feedback (N_Y) improves turn coordination. RSRI and roll–rate to rudder crossfeed (scheduled with AOA) are used for roll coordination. At low to medium AOA, full rudder pedal deflection provides ½ rudder deflection. At high AOA, the RSRI and rudder–to–rolling surface interconnects combine with rudder pedal inputs to make full rudder deflection available. At high air speeds, rudder deflection is reduced to avoid exceeding structural limits. In the takeoff and land modes, rate of change of sideslip feedback augments aerodynamic directional damping and stability. For takeoff or land modes, rudder toe–in is used to improve the longitudinal stability and to provide early rotation during takeoff or bolter. Rudder toe–in is a function of AOA with maximum toe–in (30°) at low AOA and decreasing as AOA increases.

DIRECT ELECTRICAL LINK (DEL) (all airplanes)

A direct electrical link in each axis provides continued electrical operation of the flight controls after multiple system failures make CAS operation impossible. See FCS Failure Indications and Effects, section V. In DEL, stability and control will be degraded. There are two DEL modes, digital and analog. Trim capability is not affected in digital DEL. With any axis in digital DEL, a DEL caution is displayed on the DDI. The FCS reverts to analog DEL for the ailerons and rudder if there are three digital processor failures. While stability and control are slightly worse in analog DEL than in digital DEL, the difference will probably not be noticeable to the pilot.

Pitch digital DEL provides control of the stabilators after three similar pitch rate gyro or normal accelerometer failures. There is no analog DEL mode in pitch.

Roll digital DEL provides roll control after three similar roll rate gyro failures. Trim is not affected. RSRI provides rudder displacement for roll coordination. Roll analog DEL provides an additional path to the ailerons for roll control after three digital processor failures. Analog DEL provides a direct electrical path from the stick force sensors to the aileron servos without an air data input. Analog DEL provides rudder coordination through an analog stick to rudder interconnect. There is no aileron trim capability in analog DEL.

Yaw digital DEL provides directional control after three similar yaw rate gyro or lateral accelerometer (N_Y) motion feedback sensor failures. Rudder displacement versus rudder pedal force is decreased with increasing airspeed. Yaw analog DEL provides rudder control through rudder servo commands without airspeed correction (feel) after three digital processor failures. There is rudder trim in both the digital and analog DEL mode.

MECHANICAL LINKAGE (MECH) (all airplanes)

Mechanical linkage provides backup control of the stabilators for pitch and roll control after multiple control system failures which prevent the use of digital DEL. A MECH ON caution is displayed on the DDI. See FCS Failure Indications and Effects, section V. In the mechanical mode, stick movement directly controls the stabilator actuators bypassing all force sensors, the flight control computers, all air data, all motion feedbacks, servos, and associated electrical wiring. A mode select actuator increases stabilator movement versus stick movement when the flap switch is in HALF or FULL to provide added authority for landing. Pitch trim moves the stick neutral point. Pressing the takeoff trim button centers the stick longitudinally. There is no mechanical lateral trim.

SECONDARY FLIGHT CONTROLS (all airplanes)

The secondary flight controls are the collective leading edge flaps, collective trailing edge flaps, drooped ailerons, and speed brake.

FLAPS (all airplanes)

The collective leading edge and trailing edge flaps are controlled as a function of the FCC mode to provide the desired flight characteristics throughout the flight envelope. Figure 1-12 shows representative schedules in the auto flap up mode. Maximum flap deflection is limited by Mach number and airspeed. Leading edge flaps will remain fully retracted at Mach 1.2 and above regardless of AOA. Trailing edge flaps will remain fully retracted above Mach 1.0 regardless of AOA. The flaps may not reach the deflections shown in figure 1-12 at low altitude and high airspeed.

Flap Operation (5.3.1 PROM)

SWITCH POSITION	FLAP OPERATION
AUTO	Leading edge and collective trailing edge flaps are scheduled as a function of AOA. With the wings unlocked, leading and trailing edge flaps and aileron droop are set to 0°.
HALF	Leading edge flaps are scheduled as a function of AOA. Trailing edge flaps and aileron droop are set to 30°. On the ground, the leading edge flaps are set to 12°. With the wings unlocked, aileron droop is set to 0°.
FULL	Leading edge flaps are scheduled as a function of AOA. Trailing edge flaps and aileron droop are set to 45°. On the ground, the leading edge flaps are set to 12°. With the wings unlocked, aileron droop is set to 0°.

Flap Operation (after 7.0 PROM)

SWITCH POSITION	FLAP OPERATION
AUTO	Leading and trailing edge flaps are scheduled as a function of AOA. On the ground, leading and trailing edge flaps and aileron droop are set to 0°.
HALF	Below 250 knots, leading edge flaps are scheduled as a function of AOA. Trailing edge flaps and aileron droop are scheduled as a function of airspeed to a maximum of 30° at approach airspeeds. Above 250 knots, the flaps operate in the auto flap up mode and the amber FLAPS light comes one. On the ground, the leading edge flaps are set to 12°. The trailing edge flaps and aileron droop are set to 30°. With the wing unlocked, aileron droop is set to 0°.
FULL	Below 250 knots, leading edge flaps are scheduled as a function of AOA. Trailing edge flaps and aileron droop are scheduled as a function of airspeed to a maximum of 45° at approach airspeeds. Above 250 knots, the flaps operate in the auto flaps up mode and the amber FLAPS light comes on. On the ground, the leading edge flaps are set to 12°. The trailing edge flaps and aileron droop are set to 45°. With the wings unlocked, aileron droop is set to 0°.

Gain Switch (5.3.1 PROM)

The gain switch is inoperative and lockwired in the NORM position.

Flaps Schedules

AUTO FLAPS UP MODE

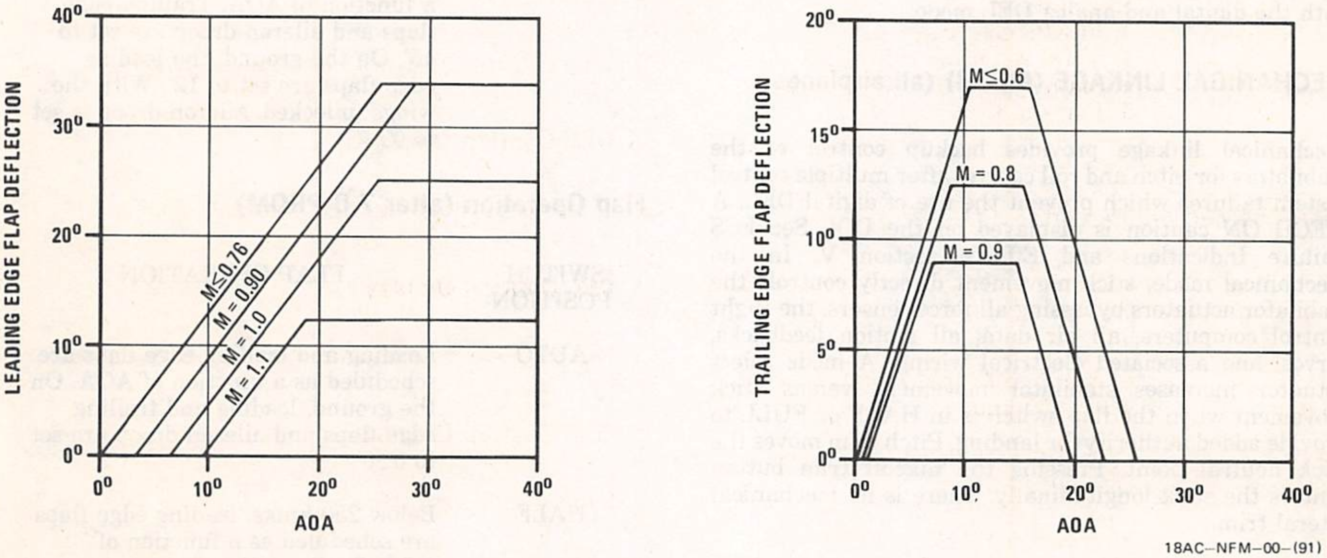


Figure 1–12. Flaps Schedules

Gain Switch (after 7.0 PROM)

The Gain switch on the FCS panel allows the pilot to select a fixed value for speed, altitude, and AOA inputs to the flight control computers and thus a fixed leading and trailing edge flap position dependent on flap switch position. The ORIDE position disables the spin recovery system.

NORM	Flaps operate as described under Flap Switch.
ORIDE	With the flap switch in AUTO, flaps are optimized for Mach 0.7 at 35,000 feet and 2° AOA. Leading and trailing edge flaps are set at about 3°. Aileron droop is set to 0°. The FLAPS light comes on and a CRUIS advisory is displayed on the DDI. Slow below 350 knots and reduce AOA below 10° before selecting ORIDE. With the flap switch in HALF, flap setting is equivalent to 133 knots at sea level and 8.1° AOA. The FLAPS light comes on and a LAND advisory is displayed on the DDI. Leading edge flaps are set to 17°. Trailing edge flaps and aileron droop are set to 30°. Do not exceed 250 knots or 15° AOA. With wings unlocked, aileron droop is set to 0°. With the flap switch in FULL, flap setting is equivalent to 133 knots at sea level and 8.1° AOA. The FLAPS light comes on and a LAND advisory is displayed on the DDI. Leading edge flaps are set to 17°. Trailing edge flaps and aileron droop are set to 45°. Do not exceed 250 knots or 15° AOA. With wings unlocked, aileron droop is set to 0°.

Flap Position Lights (5.3.1 PROM)

The HALF, FULL, and FLAPS lights are on the main instrument panel.

HALF (green)	Flap switch in HALF, airspeed below 205 knots decelerating or 215 knots accelerating, and no flap failures.
FULL (green)	Flap switch in FULL, airspeed below 165 knots decelerating or 170 knots accelerating, and no flap failures.

FLAPS (amber)	Any of the following conditions exist: 1. Flap switch in HALF and airspeed over 205 knots decelerating or 215 knots accelerating. 2. Flap switch in FULL and airspeed over 165 knots decelerating or 170 knots accelerating. 3. FLAPS OFF caution. 4. Third AOA and third back-up air data system (BADS) failure. 5. Flaps in transit

Flap Position Lights (After 7.0 PROM)

The HALF, FULL, and FLAPS lights are on the main instrument panel.

HALF (green)	Flap switch in HALF and airspeed below 250 knots.
FULL (green)	Flap switch in FULL and airspeed below 250 knots.
FLAPS (amber)	Flap switch HALF or FULL and airspeed over 250 knots, abnormal flap condition, or in spin recovery mode.

FCS CAUTIONS (5.1.3 PROM)

FCES Caution Light

The FCES (flight control electronic set) caution light, on the caution lights panel, comes on if any flight control function is lost or if a third like failure in the flight control system.

FCS Caution Display

The FCS caution, on the DDI, is displayed anytime a failure in the flight control system occurs. If the failure is transient and can be reset, pressing the FCS RESET button removes the failure caution and the FCS caution. If the failure is not reset, the failure caution remains displayed but the FCS caution is removed after approximately 9 seconds. The FCS caution is displayed again if another flight control system failure occurs.

FCS 1ST Caution Display

The FCS 1ST caution display, on the DDI, indicates that a first failure exists in pitch CAS, roll CAS, yaw CAS, maneuvering flaps, AOA, air data, aileron DEL or rudder DEL.

FCS 2ND Caution Display

The FCS 2ND caution display, on the DDI, indicates that a second failure exists (one failure away from loss of a function) in pitch CAS, roll CAS, yaw CAS or maneuvering flaps. The FCS 2ND caution inhibits the FCS 1ST caution.

P DEL Caution Display

Pitch axis is in the direct electrical link mode.

R DEL Caution Display

Roll axis is in the direct electrical link mode.

Y DEL Caution Display

Directional axis is in the direct electrical link mode.

R OFF Caution Display

Ailerons are inoperative.

Y OFF Caution Display

Rudders are inoperative.

MECH ON Caution Display

Stabilators are in the mechanical linkage mode.

FX GAINS Caution Display

Flight controls in FX GAINS mode. For air data failures, controls scheduled with air data are set to low gains with flap switch AUTO or high gains with flap switch HALF or FULL. For AOA failures, controls scheduled with AOA are set to either high or low AOA values depending on the position of the leading edge flaps at the time of failure.

FLAPS OFF Caution Display

Leading and/or trailing edge flaps inoperative.

NO LIMITER Caution Display

Wing pylon mounted air–to–ground stores or tanks set in armament computer with rack hooks for those stores closed or all stores HUNG and roll rate limiting inoperative. Do not exceed ½ lateral stick. Roll sensitivity is increased.

FCS CAUTIONS (after 7.0 PROM)

FCS CAUTIONS (after 7.0 PROM)

FCES Caution Light

The FCES (flight control electronic set) caution light, on the caution lights panel, comes on if any flight control function is lost or if a third like failure occurs in the flight control system.

FCS Caution Display

The FCS caution, on the DDI, is displayed anytime a failure in the flight control system occurs. If the failure is transient and can be reset, pressing the FCS RESET button removes the failure caution and the FCS caution. If the failure is not reset, the failure caution remains displayed but the FCS caution is removed after approximately 9 seconds. The FCS caution is displayed again if another flight control system failure occurs.

DEL ON Caution Display

Any axis in digital DEL

RUD OFF Caution Display

Either rudder off

AIL OFF Caution Display

Either aileron off

MECH ON Caution Display

Stabilator mechanically controlled

FLAPS OFF Caution Display

Any flap off

FLAP FRZ Caution Display (5.3.1 PROM)

Flaps frozen and not scheduling properly (AOA or BADS failed).

FLAP SCHED Caution Display (After 7.0 PROM)

Flaps frozen and not scheduling properly (AOA or BADS failed).
Leading edge flap at least 10° off schedule and AOA over 12°.

NWS Caution Display

Flashing – loss of hydraulic pressure
Steady – nosewheel steering inoperative

ROLL RATE Caution Display

Wing air–to–ground stores or tanks present and roll rate limiter inoperative. Do not exceed ½ lateral stick. Roll sensitivity is increased.

FC AIR DAT Caution Display

Left and right air data probes disagree

AUTO PILOT Caution Display

Uncommanded autopilot disengagement.

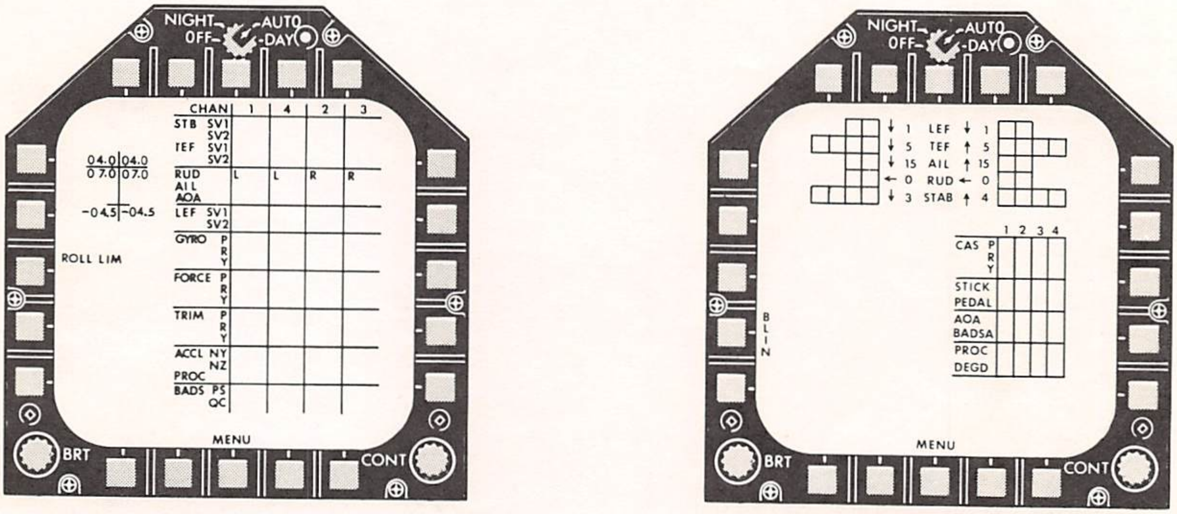
VOICE ALERT (all airplanes)

With 5.3.1 PROM an **FCS 2ND** caution is accompanied by a "flight controls, flight controls" voice alert. After 7.2 PROM, any FCS caution except **FCS**, **NWS**, and **NO LIMITER** is accompanied by a "flight controls, flight controls" voice alert.An FCS HOT caution is accompanied by a "flight computers hot, flight computers hot" voice alert.

FCS Status Display

An FCS status display (figure 1-13) may be selected on a DDI. The display presents leading edge flap, trailing edge flap, and stabilator positions in degrees on the left side of the DDI. Stabilator position is shown as – for trailing edge up (nose up) and + for trailing edge down (nose down). The right side of the DDI contains a failure matrix where an **X** indicates a particular component failure. Refer to FCS Failure Indications and Effects, section V for description of various failure indications. The words **ROLL LIM** appears below the stick airplane when roll rate limiting is engaged.

FCS Status Display



Airplanes thru 161924

Airplanes 161925 and up

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Figure 1–13. FCS Status Display

SPEEDBRAKE (all airplanes)

The speedbrake is mounted between the vertical stabilizers. It is controlled by a throttle mounted switch using left 28 volt dc bus power. It is powered by the HYD 2A system. Airborne after 7.0 PROM, the speedbrake is automatically retracted below 250 knots when not in the auto flaps up mode. The speedbrake will extend with the flaps HALF or FULL so long as the switch is held in EXTEND. This is not recommended. The speedbrake will operate normally on the ground.

Speedbrake Switch (all airplanes)

The speedbrake switch is on the right throttle grip and has three unmarked positions.

Aft detent	Extends the speedbrake as long as the switch is held aft. Springloaded to center detent.
Forward detent	Retracts the speedbrake or maintains the speedbrake retracted and prevents creep.
Center detent	Stops the speedbrake in any position. The speedbrake may slowly creep open.

SPD BRK Light (all airplanes)

The SPD BRK light, on the main instrument panel, comes on anytime the speedbrake is not fully retracted.

AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS)

NOTE

Airplanes with 5.3.1 PROM do not have an AFCS.

The automatic flight control system (auto pilot) has two basic modes: pilot relief and data link. The pilot relief mode consists of heading hold, heading select, attitude hold, barometric altitude hold, radar altitude hold, and control stick steering. The data link mode consists of automatic carrier landing, precision course direction, vector approach, and automatic throttle control. Control of the automatic flight control modes is accomplished by the autopilot disengage/nosewheel steering switch on the control stick, heading set switch on heading and course set switches panel, and the switches on the up front control (see figure 1-14). Before any mode can be selected bank must be less than or equal to 70°, pitch must be less than or equal to 45° and the A/P pushbutton must be pressed. Initial engagement of the AFCS provides heading hold. The option display windows and corresponding buttons provide selection of other modes. The option displays are: ATTH (attitude hold), HSEL (heading select), BALT (barometric altitude hold) and RALT (radar altitude hold). When an option is selected a colon (:) appears in front of the selected display and the selected mode appears on the advisory display and the HUD. If an option is not available, it will not be displayed.

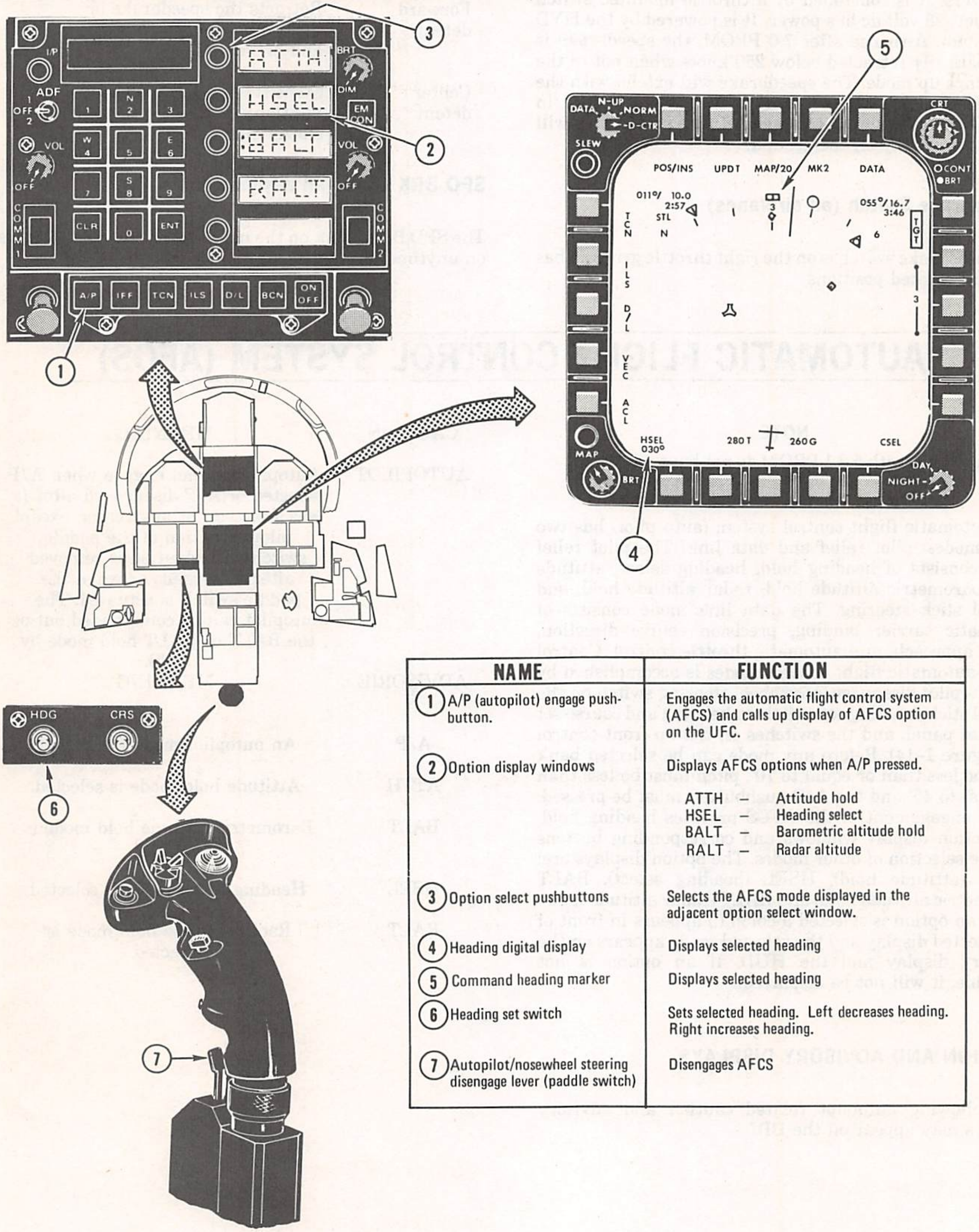
CAUTION AND ADVISORY DISPLAYS

The following autopilot related caution and advisory displays may appear on the DDI:

CAUTION	MEANING
AUTOPILOT	Autopilot did not engage when A/P selected or A/P disengaged after it was selected (for any reason except pilot actuation of the paddle switch). The caution is removed after 10 seconds or when the paddle switch is actuated. The autopilot can be commanded out of the BALT or RALT hold mode by CSS.

ADVISORIES	MEANING
A/P	An autopilot mode is selected.
ATTH	Attitude hold mode is selected.
BALT	Barometric altitude hold mode is selected.
HSEL	Heading select mode is selected.
RALT	Radar altitude hold mode is selected.

AFCS Controls and Indicator



NAME	FUNCTION
① A/P (autopilot) engage pushbutton.	Engages the automatic flight control system (AFCS) and calls up display of AFCS option on the UFC.
② Option display windows	Displays AFCS options when A/P pressed. ATTH – Attitude hold HSEL – Heading select BALT – Barometric altitude hold RALT – Radar altitude
③ Option select pushbuttons	Selects the AFCS mode displayed in the adjacent option select window.
④ Heading digital display	Displays selected heading
⑤ Command heading marker	Displays selected heading
⑥ Heading set switch	Sets selected heading. Left decreases heading. Right increases heading.
⑦ Autopilot/nosewheel steering disengage lever (paddle switch)	Disengages AFCS

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Figure 1-14. AFCS Controls and Indicators

PILOT RELIEF MODES

AUTOPILOT

The autopilot is engaged by pressing the A/P pushbutton on the UFC. Engagement is indicated by the A/P advisory on the DDI and autopilot mode options on the UFC. At this time the aircraft maintains the existing pitch attitude. If roll attitude is less than or equal to ±5° at engagement, the magnetic heading is maintained. If roll attitude at time of engagement is greater than ±5°, the roll attitude is maintained. The pitch attitude hold reference can be changed with pitch control stick steering (CSS) to any value between ±45° pitch. The pitch attitude reference can also be changed with the trim switch on the control stick at a rate of 0.5 degrees per second. The roll attitude hold reference (if roll is greater than ±5°) can be changed with roll CSS to any value between 5° and 70° of roll. The roll attitude reference can also be changed using the trim switch on the stick at a rate of 2 degrees per second. The magnetic heading reference (if roll is less than or equal to ±5°) can be changed, or initially set with roll CSS. The roll trim switch also can change the reference magnetic heading.

ATTITUDE HOLD

Attitude hold is engaged by pressing the option pushbutton next to the option display window displaying ATTH. Engagement is indicated by a colon in the ATTH option window. At this time the aircraft maintains the existing pitch and roll attitude. The pitch attitude hold reference can be changed to any value between ±45° with pitch CSS or with the trim switch on the control stick (0.5 degrees per second). The roll attitude hold reference can be changed to any value between ±70° with roll CSS or with the trim switch on the stick (2 degrees per second).

BAROMETRIC ALTITUDE HOLD

To establish barometric altitude hold, press the button next to the option display window displaying BALT. The existing barometric altitude at time of engagement is captured and maintained. Heading or attitude hold is maintained, depending upon which mode was previously engaged. The operating range is 0 to 70,000 feet. CSS causes reversion to heading or attitude hold, depending upon which was previously engaged.

HEADING SELECT

To establish heading select mode, select the desired heading on the HSI display by using the heading set switch, located to the left of the center DDI. Press the button next to the option display window displaying HSEL. The aircraft turns from existing heading through the smallest angle to the selected heading. Heading hold is reestablished after the selected heading is captured. Existing pitch attitude is maintained. CSS is available.

RADAR ALTITUDE HOLD

To establish radar altitude hold, press the pushbutton next to the option display window displaying RALT. Engagement is indicated by a colon appearing in the window next to RALT. The existing radar altitude is maintained upon engagement. If no other mode is selected, the lateral axis control remains in heading hold. In this configuration, either CSS or the roll trim switch can be utilized with automatic turn coordination up to 45° with altitude maintained.

LANDING SYSTEMS

The landing system is made up of the landing gear, nosewheel steering, brakes, launch bar, and arresting hook.

LANDING GEAR SYSTEM

The landing gear system is electrically controlled and hydraulically operated. Before the gear can be raised normally, the weight must be off the wheels and the launch bar must be retracted. The main gear is retracted aft into the fuselage and the nose gear is retracted forward. When the gear is extended all gear doors remain open.

LANDING GEAR CONTROL HANDLE

The landing gear is controlled by a two-position, wheel-shaped handle on the lower left side of the main instrument panel. Moving the handle up (with weight off the wheels) raises the gear. Moving the handle down lowers the gear. On the ground (weight on wheels), movement of the handle from DN to UP is prevented by a solenoid in the landing gear control panel. However, a down lock override button next to the gear handle makes it possible to override the weight on wheels switch and retract the gear on the ground by depressing and holding the override button until the gear handle is moved out of DN. The button can then be released and the handle is free, and can be moved to UP. If the gear handle cannot be moved from DN to UP after the weight is off the wheels, a failure has occurred in the lock down solenoid circuit. In this case, the override button allows the handle to be raised.

LANDING GEAR WARNING LIGHTS/TONE

The landing gear warning light is a red light in the gear handle. The light comes on when the gear is in transit and remains on until all three gear are down and locked when DN is selected, or all the gear doors are closed when UP is selected. The light will remain on with the gear down and locked if the left or right main landing gear planing link is not locked. In addition, the gear handle light functions as a wheel warning in conjunction with a warning tone. The gear handle light flashes and a continuous rate beeping tone sounds when the gear handle is in the UP position, the aircraft is below 175 knots, altitude is less than 7,500 feet and rate of descent is greater than 250 feet per minute. The warning tone may be silenced by pressing the warning tone silence button next to the gear handle.

CAUTION

The landing gear warning light will be inhibited upon an indication that an aircraft WEAPON MODE of operation has been selected.

LANDING GEAR POSITION/PLANING LINK FAILURE LIGHTS

There are three green landing gear position lights marked NOSE, LEFT and RIGHT, above the landing gear control handle. The lights indicate that the gear is down and locked, or that a planing link is not locked. The NOSE gear light comes on steady when the nose gear is down and locked. The LEFT and RIGHT lights come on steady when their respective gear is down and locked and flash if the gear is down and locked but a related planing link is not locked.

EMERGENCY GEAR EXTENSION

Emergency gear extension is done by rotating the gear handle 90° clockwise and pulling (approximately 1.5 inches) to the detent where the handle locks in place. This can be done with the handle in either UP or DN; however, the handle must be rotated 90° before it is pulled. Rotating and pulling the gear handle opens the valves for the emergency landing gear control, the APU accumulator and the emergency brake accumulator. The gear extends by a combination of free fall and a force from the side brace downlock actuator.

NOSEWHEEL STEERING SYSTEM

The nosewheel steering system is a combination shimmy damper and dual mode steering system. It is electrically controlled by two switches on the stick grip and hydromechanically operated through inputs from the rudder pedals and flight control computers. With the flight control computers operating, momentarily pressing the nosewheel steering button activates and engages nosewheel steering in the low mode ($\pm16°$) and NWS is displayed on the HUD. Holding the nosewheel steering button depressed will select the high mode ($\pm75°$) and NWS HI is displayed on the HUD. After 7.2 PROM with the wing handle unlocked and nosewheel steering in the low mode, pressing the nosewheel steering button causes the nosewheel steering to go to the high mode where it will remain without holding the button pressed. Momentarily pressing the autopilot disengage switch (paddle switch) will disengage nosewheel steering until reengaged by the nosewheel steering button. If the launch bar is extended, nosewheel steering is disengaged; however, the low mode may be engaged by pressing and holding the nosewheel steering button. On the ground, nosewheel steering is disengaged when power is removed from the aircraft. Nosewheel steering is also disengaged with weight off the nose gear. During landing, nosewheel steering is automatically engaged in the low mode with weight on the nose gear. If the high mode is desired during taxi, press and hold the nosewheel steering button. If the nosewheel steering system fails, NWS and FCS is displayed on the DDI as a caution, the MASTER CAUTION light comes on, and the NWS or NWS HI display is removed from the HUD. When failed, the nosewheel steering system reverts to a free swivelling mode.

BRAKE SYSTEM

The main landing gear wheels have full power brakes operated by toe action on the rudder pedals. An anti-skid system is combined with the normal system to prevent wheel skid. With anti-skid ON and brakes applied, a touchdown protection circuit prevents braking until 3 seconds after touchdown.

ANTI-SKID SYSTEM

The anti-skid system is electrically controlled by a two position switch on the lower left portion of the instrument panel. The switch is lever-locked to OFF. An advisory SKID display on the DDI is displayed if the landing gear is down and anti-skid ON is not selected. If anti-skid fails, the DDI displays ANTI SKID as a caution and the MASTER CAUTION light comes on. The anti-skid system is disabled at approximately 30 knots to prevent loss of brakes. Also, anti-skid is not available when the emergency brake system is activated.

EMERGENCY BRAKE SYSTEM

The emergency brake system uses normal system brakes with independent hydraulic lines carrying emergency hydraulic pressure to the brake shuttle valve. The emergency brakes are supplied with hydraulic pressure by the brake accumulator backed up by the APU accumulator. Brake accumulator pressure is shown on a pressure gage on on the lower left corner of the main instrument panel and is redlined to indicate pressure below 2000 psig. However, an indication of 2000 psig does not mean the onset of degraded braking. It is a warning that there are five full brake applications remaining before BRK ACCUM is displayed on the DDI as a caution and the MASTER CAUTION light comes on. This caution is displayed at 1750 psi and represents the worst condition (maximum temperature) where the brake accumulator may be empty. The system is activated by pulling the emergency/parking brake handle out to detent. This action routes brake accumulator pressure to the disc brakes proportionally to pilot input through toe action on the rudder pedals. The system is deactivated by pushing the emergency/parking brake handle back into the stowed position.

CAUTION

Due to system friction, the emergency parking brake handle may not return to the stowed position without pilot assistance (positive push) during the last part of its travel. If the handle is not fully stowed after selecting emergency brakes, the emergency brake system will remain selected. Normal brakes and anti-skid protection cannot be regained until the handle is fully stowed.

EMERGENCY/PARKING BRAKE HANDLE

The combination emergency/parking brake handle (figure 1-15) is on the lower left corner of the main instrument panel. The handle is shaped such that "EMERG" is visible to the pilot when the handle is in the stowed or emergency position and "PARK" is visible to the pilot when the handle is rotated to the park position.

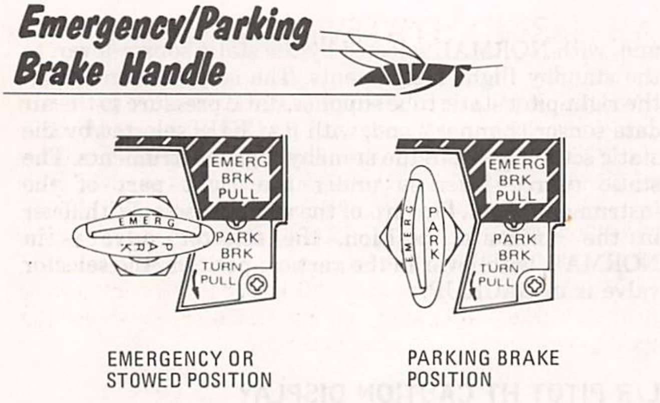

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Figure 1–15. Emergency/Parking Brake Handle

PARKING BRAKE SYSTEM

The parking brake system uses the same hydraulic lines, accumulators and actuation handle as the emergency brake system. The system is activated by rotating the emergency/parking brake handle 90° counterclockwise from the horizontal stowed position and pulling it out to a positive locked position. If the emergency brakes have been activated, it will be necessary to reposition the handle to the stowed position then rotate it 90° counterclockwise and pull it to the locked position to select parking brakes. This action applies non–regulated pressure to the disc brakes. With the INS on, the parking brake set, and both throttles above about 80% rpm, the PARK BRK caution and MASTER CAUTION come on. To release the parking brake, rotate the emergency/parking brake handle 45° counterclockwise from the extended position. This will release the lock and allow the handle to return to the horizontal stowed position.

LAUNCH BAR SYSTEM

The launch bar is hydraulically extended and mechanically retracted by redundant springs. A two position (EXTEND and RETRACT) launch bar switch on the lower left corner of the main instrument panel controls launch bar operation. As the launch bar extends the green L BAR advisory light comes on. When the launch bar is fully extended it is held against the deck by deck load control springs. The control springs allow vertical movement of the launch bar during taxi. As the aircraft is taxied into the launch gear the launch bar drops over the shuttle and is held captive in the extended position as the shuttle is tensioned. On airplanes thru 161715, when both throttles are advanced to or above military power, a throttle switch is made, the green L BAR advisory light goes out and the launch bar switch returns to retract. If the launch bar switch is not deenergized to RETRACT after the throttles are advanced to military, the red L BAR warning light comes on. On airplane 161716 and up, the launch bar switch does not return to RETRACT when both throttles are advanced to MIL or above. The green L BAR advisory light goes out when the switch is placed to RETRACT; however, the red L BAR warning has no function on the deck. At the completion of the catapult stroke, launch bar/catapult separation occurs and the return springs cause launch bar retraction which allows the landing gear to be retracted. If the launch bar fails to retract after the aircraft is launched, the red L BAR warning light comes on and the nosewheel will not retract. A launch bar circuit breaker is on the left essential circuit breaker panel and when pulled deenergizes the launch bar electrical system.

ARRESTING HOOK SYSTEM

The arresting hook system consists of a retract actuator/damper, fail safe manual latch and release, universal hook shank pivot and replaceable hook point. Hook control is a manual system which automatically extends the hook in case of a failure of the release system. The arresting hook handle and hook light are on the lower right main instrument panel. The hook light remains on except when the hook is up and latched or is fully down. Hook extension is a free–fall action assisted by a nitrogen charge in the actuator cylinder. Hook motion is dampened laterally by a liquid spring in the hook shank and vertically by the damper in the retract actuator cylinder which minimizes hook bounce and provides hold down force for arresting cable engagement.

ARRESTING HOOK HANDLE

To extend the arresting hook, place the arresting hook handle down. The hook light comes on when the hook is in transit and goes out when the hook is full up or down. The light remains on if the hook is in contact with the deck and is prevented from reaching the hook down proximity switch. To retract the arresting hook, place the arresting hook handle up.

WING FOLD SYSTEM

Each outer wing panel is folded upward to a vertical position by a wing fold mechanical/electrical drive. A wing fold unlock flag in the upper surface wing fold area provides a visual indication of the wing lock pins in the unlocked position. The wing lock control and wing fold/spread control are combined in the wing fold handle on the lower right main instrument panel. A wing safety switch is located so that a safety pin can be manually installed from the underside of the wing when absolute prevention of wing fold or spread is desired. The ailerons are locked in neutral when the wings are folded.

WING FOLD HANDLE

Normal folding and spreading the wings is accomplished through operation of the wing fold handle. To fold the wings, press the detent on the underside of the wing fold handle, pull out and rotate counterclockwise to FOLD. The MASTER CAUTION light will come on, a WING UNLK display appears on the DDI and the wing fold unlock flag appears. To spread the wings, rotate the wing fold handle clockwise to SPREAD. To lock the wings after they have fully spread, push the handle in. When the lock pins are in place the WING UNLK display on the DDI disappears and the wing fold unlock flag is down flush with the top surface of the wing. The wings can be stopped and held in any intermediate position by placing the wing fold handle to HOLD. Normally 115 volts ac is required to spread the wings and 115 volts plus hydraulic power to fair the ailerons and fold the wings. The wings can be folded manually if the ailerons are manually faired. The wings are unlocked by pulling out on the wing fold handle. The drive unit can then be driven with a speed handle through an opening in the lower wing surface just inboard of the trailing edge of the wing fold area.

INSTRUMENTS

Refer to foldout section for cockpit instrument panel illustration. For instruments that are an integral part of an aircraft system, refer to that system description in this section.

PITOT–STATIC SYSTEM

There are two pitot static tubes mounted under the nose on each side forward of the nosewheel well. Each tube contains one pitot source and two static sources.

PITOT HEATER SWITCH

The pitot heater switch on the ECS panel has positions ON and AUTO.

AUTO	Heaters are on when airborne.
ON	Heaters are on when ac power available.

PITOT PRESSURE

Pitot pressure from the right pitot tube is supplied to the air data computer and the the air data sensor channel two. Pitot pressure from the left pitot tube is supplied to the airspeed indicator and the air data sensor channel 1.

STATIC PRESSURE

One static source from each pitot static tube are teed together and this presssure is supplied to the air data computer. The second source from the left pitot static tube supplies static pressure to the air data sensor channel 1 and, with NORMAL selected by the static source lever, to the standby flight instruments. The second source from the right pitot static tube supplies static pressure to the air data sensor channel 2 and, with BACKUP selected by the static source lever, to the standby flight instruments. The static source lever is under the right part of the instrument panel, forward of the right console. With lever in the horizontal position, the selector valve is in NORMAL, with lever in the vertical position, the selector valve is in BACKUP.

L/R PITOT HT CAUTION DISPLAY

With pitot heater switch in ON or AUTO while airborne, or in ON on the ground; a L PITOT HT and/or R PITOT HT caution display comes on if a malfunction occurs in the heater circuits.

ATTITUDE REFERENCE INDICATOR

The attitude reference indicator is a self–contained electrically driven gyro–horizon type instrument. It is normally powered by the right 115 vac bus. If this power fails it is automatically powered by an inverter operating off the essential 28 vdc bus. An OFF flag appears if both power sources fail or the gyro is caged. The gyro cages to 0° pitch and roll regardless of airplane attitude. Power should be applied for at least one minute before caging. The indicator displays roll through 360°. Pitch display is limited by mechanical stops at approximately 90° climb and 80° dive. As the aircraft reaches either stop, the gyro tumbles 180° in roll. A needle and ball are at the bottom of the instrument. A one needle width turn is 90° per minute.

STANDBY AIRSPEED INDICATOR

The standby airspeed indicator displays airspeed from 60 to 850 knots indicated airspeed. It operates directly off left pitot pressure and left static pressure with NORMAL selected by the static source selector lever or right static pressure with BACKUP selected.

STANDBY ALTIMETER

The standby altimeter is a counter-pointer type. The counter drum indicates altitude in thousands of feet from 00 to 99. The long pointer indicates altitude in 50 foot increments with one full revolution each 1000 feet. A knob and window permit setting the altimeter to the desired barometric setting. This setting is also used by the air data computer. The standby altimeter operates directly off the left static pressure with NORMAL selected by the static source selector lever or right static pressure with BACKUP selected.

RADAR ALTIMETER SET (AN/APN–194(V))

The radar altimeter set indicates clearance over land or water from 0 to 5000 feet. Operation is based on precise measurement of time required for an electromagnetic energy pulse to travel from the aircraft to the ground terrain and return. Voice alert and visual warnings are activated when the aircraft is at or below a selectable low altitude limit. The set consists of a receiver–transmitter, individual transmitting and receiving antennas, and a height indicator. The receiver–transmitter produces the energy pulses, transmits the energy to the ground, receives the reflected signal and processes this data for display as altitude by the head–up display unit (HUD) and the height indicator. The height indicator, on the instrument panel, consists of a calibrated scale from 0 to 5000 feet, a push to test switch, a low altitude index pointer, an altitude pointer, an OFF flag, a low altitude warning light, and a BIT light. Other indicators and controls used with the electronic altimeter set are the left or right digital display indicators (DDI) on the instrument panel (for BIT checks), an altitude switch, and the head–up display. The energized position of the emission control (EMCON) switch on the upfront control panel inhibits operation of the radar altimeter.

CONTROLS AND INDICATORS

Push to Test Switch

Turning this switch clockwise applies power to the set. Further clockwise rotation positions the low altitude index pointer to increasing altitudes. Pushing in on the switch activates the BIT checks.

Altitude Pointer

This pointer indicates the altitude of the aircraft from 0 to 5000 feet above the terrain.

Low Altitude Warning Light

This light (red) comes on to indicate the low altitude as selected by the low altitude index pointer.

Voice Alert Warning

A voice alert warning "ALTITUDE, ALTITUDE" is heard in the pilot's headset whenever the aircraft descends below the altitude set in the radar altimeter by the low altitude index pointer.

Low Altitude Index Pointer

This pointer sets the altitude at which the low altitude warning light comes on and the voice alert warning is heard.

BIT light

This light (green) comes on during initiated BIT to indicate that the altimeter set is GO.

OFF Flag

The OFF flag comes into view to indicate that the set is off or not tracking because the return signal is not strong enough. At this time the altitude pointer is driven behind the mask on the indicator face.

Altitude Switch

The altitude switch, on the HUD control panel, has positions of BARO and RDR. When the switch is set to RDR (radar), the altimeter altitude followed by an R is displayed in the upper right part of the HUD display. If radar altitude becomes invalid, such as the aircraft exceeding the 5000 feet AGL radar altimeter limit, barometric altitude is displayed and a B next to the altitude flashes to indicate barometric altitude is being displayed.

BIT Checks

BIT checks are normally performed with the left or right DDI on and the altimeter set turned on. The checks can also be performed using only the altimeter set height indicator. To manually start the normal BIT from the DDI, press the menu pushbutton to obtain the menu display and then press the BIT pushbutton to obtain the BIT control display. Then press the ICS/IBS/RALT pushbutton. The altitude pointer on the height indicator will indicate greater than 5000 feet and the OFF flag appears for 1 second. After 1 second the pointer indicates 100 feet, the BIT light comes on, the low altitude warning light comes on, and the voice alert warning is heard in the headset. At this time the BIT status message on the BIT control display reads GO indicating that the set checks out good. To BIT check the set using only the height indicator, press the push to test switch. The same indications will appear on the height indicator as with the normal BIT checks using the DDI.

STANDBY RATE OF CLIMB INDICATOR

The standby rate of climb indicator displays vertical speed on a scale from 0 to ±6000 feet. It operates directly off the left static pressure with NORMAL selected by the static source selector lever or right static pressure with BACKUP selected.

CLOCK

A standard 8 day clock is installed.

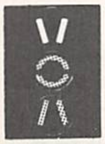
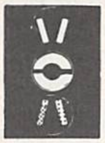
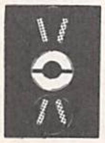
STANDBY MAGNETIC COMPASS

A conventional aircraft magnetic compass is mounted on the right windshield arch.

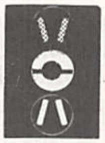
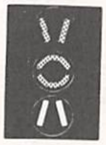
ANGLE-OF-ATTACK INDEXER

The angle-of-attack indexer is mounted to the left of the HUD. It displays approach angle of attack (AOA) with lighted symbols; corresponding AOA indications are shown on the HUD. The indexer operates only with the landing gear down and weight off the gear. The lighted symbol(s) flash if the arresting hook is up and the hook bypass switch, on the left vertical panel, is in CARRIER. The symbols will not flash with the arresting hook up and the hook bypass switch in FIELD. The switch is solenoid held to FIELD and automatically goes to CARRIER when the arresting hook is lowered or aircraft power is removed. The AOA indexer knob on the HUD controls dimming of the symbols. All symbols light when the lights test switch on the interior lights control panel is held to TEST.

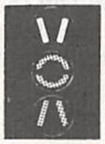
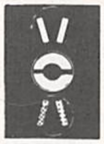
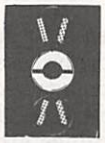
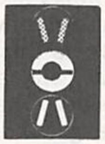
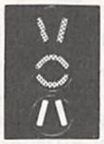
Indexer indications on airplanes 161520 and up

Symbol	AOA	Airspeed
	9.3 - 90.0°	Slow
	8.8 - 9.3°	Slightly Slow
	7.4 - 8.8°	On Speed

Indexer indications on airplanes 161520 and up

	6.9 - 7.4°	Slightly Fast
	0 - 6.9°	Fast

Indexer indications on airplanes 161353 thru 161519

Symbol	AOA	Airspeed
	8.9 - 90.0°	Slow
	8.1 - 8.9°	Slightly Slow
	6.9 - 8.1°	On Speed
	6.4 - 6.9°	Slightly Fast
	0 - 6.4°	Fast

NOTE

On airplanes 161353 thru 161519 with mission computer operational flight program ID number 150 or greater loaded but without the latest configuration of air data computer installed, a discrepancy will result between optimum approach angle indications provided by the angle-of-attack bracket on the HUD and the angle-of-attack indexer lights. Thus, flying On Speed (velocity vector centered in AOA bracket) on the HUD will produce a Slightly Slow indication on the indexer lights. On the other hand, flying On Speed on the indexer lights will result in a slightly fast indication by the HUD angle-of-attack bracket display. Use of either instrument to set up the optimum approach angle is considered acceptable.

AVIONICS SUBSYSTEM

The avionic subsystem combines the integration and automation needed for one-man operability with the redundancy required to ensure flight safety and mission success. Key features of the system include highly integrated controls and displays; dual, redundant MIL-STD-1553 digital multiplex (MUX) buses; a highly-survivable quad-digital, control-by-wire primary flight control system; a 1.5 nm/hr inertial navigation set with carrier alignment capability; and extensive built-in-test capability. A block diagram of the avionic subsystem is shown in Figure FO-8. The avionic subsystems operates under the control of two mission computers with primary data transfer between the mission computers and the other avionic equipment via the MUX buses.

MISSION COMPUTER SYSTEM

The mission computer system consists of two digital computers (No. 1 and No. 2) which are high speed, stored program, programmable, general purpose computers with core memory. Computer deselection is made with the MC switch on the MC/HYD ISOL panel. The two mission computers interconnect with the primary avionic equipment via the avionic multiplex (MUX) buses. Each mission computer contains 64K sixteen-bit words of programmable memory. Mission computer No. 1 referred to as the navigation computer, performs processing for navigation, control/display management, aircraft built-in-test (BIT), status monitoring operations and backup for mission computer No. 2. MC2, referred to as the weapon delivery computer, performs processing for air-to-air combat, air-to-ground attack, tactical control/display, and backup for MC1. There are three avionic MUX bus channels (Figure 1-16) with redundant paths (X and Y) for each channel. Channel 1 links the mission computers and the flight control computers, air data computer, control converter (communication system control), armament control-processor set (stores management set), signal data recorder, HARM command launch computer, left digital display Indicator, and the two ARC-182 Radios. Channel 2 links the mission computers and the inertial navigation set, radar set, forward looking infrared (FLIR) detecting set, laser detector tracker/strike camera, two-way data link, and right digital display indicator. Channel 3 provides data transfer between the two mission computers.

The mission computer system performs the following:

a. Computes and controls the data sent to the multipurpose display group.
b. Uses input data to compute and generate missile launch and weapon release commands.
c. Provides for mode control and option select for various avionics systems.
d. Provides mode control and option select data from the multipurpose display group to avionic systems for control and computation.
e. Outputs built-in test (BIT) initiate signals to various avionics systems.
f. Receives equipment operational status from avionic and non-avionic systems. The mission computer system uses equipment status for multipurpose display group BIT status and advisory and caution display generation.

The computers receive inputs for navigational data and steering command computations from the inertial navigation system, air data computer system, electronic flight control system, multipurpose display group, tacan, backup attitude and the navigation system. The computers control display symbology and information presented to the pilot by the multipurpose display group.

MISSION DATA ENTRY

Mission data (date and flight number) is entered into the mission computer for data recorder documentation. To enter data into the mission computer perform the following:

a. On the DDI - PRESS MENU, CHKLST, THEN ID
b. On the UFC - ENTER DATE IN OPTION 1
c. On the UFC - ENTER FLIGHT IN OPTION 2

MC/HYD ISOL PANEL

The MC switch has positions of 1 OFF, 2 OFF, and NORM. Placing the switch to 1 OFF turns off digital computer No. 1. Placing the switch to 2 OFF turns off digital computer No. 2. With the switch set to NORM, both No. 1 and No. 2 digital computers are turned on.

MASTER MODES

There are three master modes of operation: navigation, air-to-air (A/A), and air-to-ground (A/G). The controls, displays, and the avionic equipment operation are tailored as a function of the master mode which the pilot has selected. The navigation master mode is entered automatically when power is applied to the aircraft, when the air-to-air or air-to-ground modes are deselected or when the landing gear is down. The A/A master mode is entered, either by pressing the A/A master mode button alongside the left DDI, or by selecting an A/A weapon with the A/A weapon select switch on the control stick. The A/G master mode is selected by pressing the A/G master mode button. The selection is performed by the stores management set (SMS), and the SMS identifies the selected master mode to the mission computer.

STEERING INFORMATION

The sources of steering information available in the NAV master mode are waypoint, tacan, instrument landing system and data link. The data link modes available in the NAV master mode are vector and automatic carrier landing. Tacan and waypoint steering are mutually exclusive and selecting one automatically deselects the other. However, data link, ILS, and tacan (or waypoint) steering can be provided simultaneously. The ACL mode

Mission Computer Functions and Multiplex System

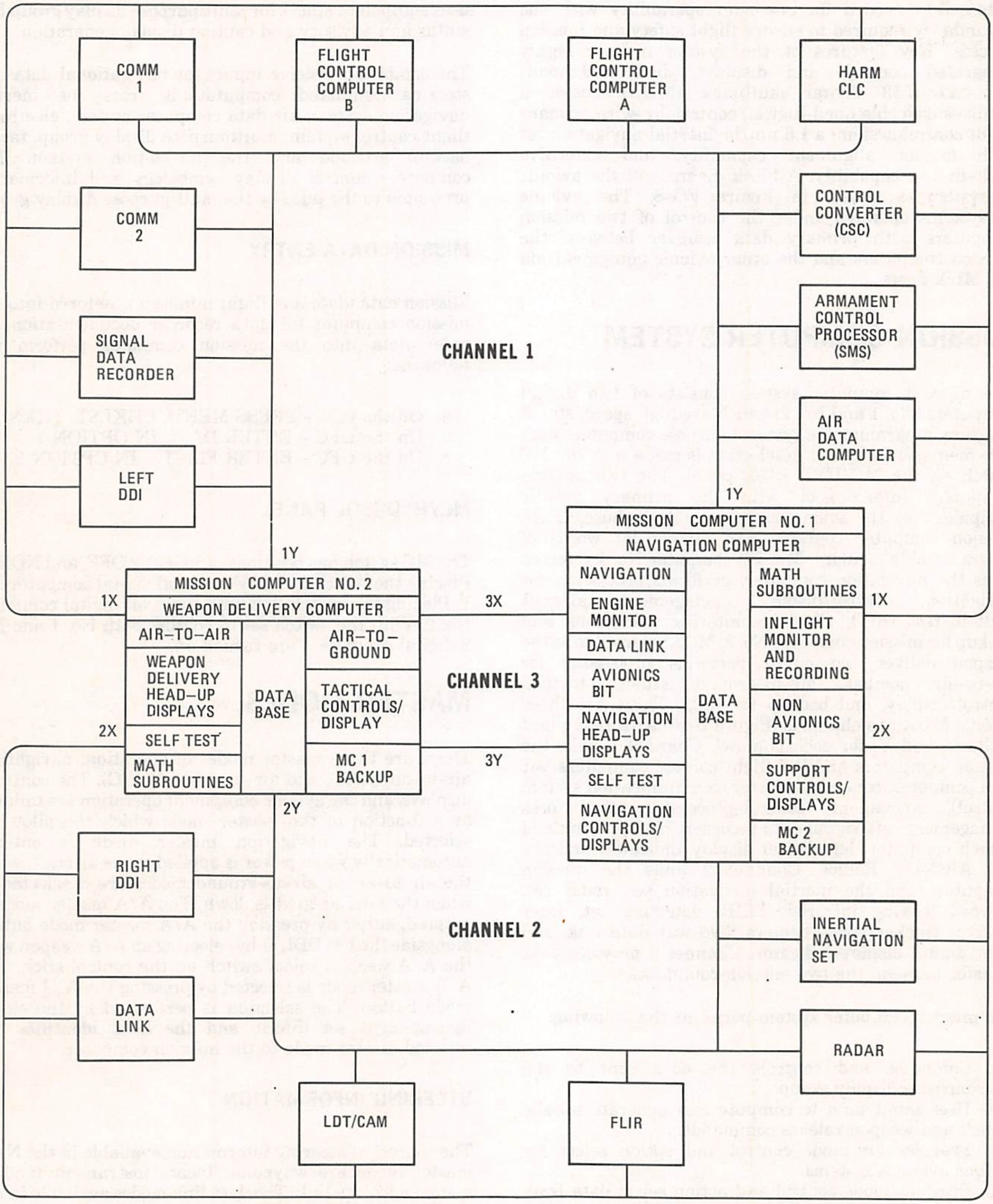


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Figure 1-16. Mission Computer Functions

is selectable only in the NAV master mode, but the vector mode is available in all master modes.

COCKPIT CONTROLS AND DISPLAYS

The cockpit controls and displays which are used for navigation operation are on the multipurpose display group and on the upfront control (UFC).

MULTIPURPOSE DISPLAY GROUP

The multipurpose display group consists of the right digital display indicator (DDI), the left DDI, the center HI, the head-up display unit (HUD), the CRS (course) set switch, and the HDG (heading) set switch. The multipurpose display group presents navigation, attack, and aircraft attitude display to the pilot. The multipurpose display group converts information received from the mission computer system to symbology for display on the right and left DDI's, the horizontal indicator, and the HUD. The HUD camera records the outside world and HUD symbology. The digital display indicators and the horizontal indicator contain pushbuttons for display selection and various equipment operating modes. Refer to Section VII for detailed description and operation of each component.

RIGHT AND LEFT DIGITAL DISPLAY INDICATORS (DDI)

The right and left DDI's are physically and functionally interchangeable giving the ability to display desired information on either indicator or using either indicator to control the HUD or horizontal indicator displays. The left indicator is used primarily for stores status, built-in test status, engine monitor, caution, and advisory displays. The right indicator is normally used for radar and weapon video displays. A description of the various switches and controls on the right and left DDI's follows.

NOTE

> It is possible that a transient condition may cause the displays to blank or provide an erroneous display on the left or right DDI, HI, or HUD. The problem may be cleared by manually cycling the power to the right or left DDI.

Brightness Selector Knob

Placing this rotary knob to OFF prevents the indicator from operating. Placing the knob to NIGHT provides a lower brightness control range (with 3 settings) and no automatic contrast control. The knob in the AUTO position allows automatic brightness control circuits to compensate display brightness for changes in ambient lighting. Turning the knob to DAY provides higher brightness control range with no automatic contrast control.

Brightness Control

This knob varies the intensity of the presentation.

Contrast Control

This knob varies the contrast between symbology and the dark background on any level of brightnss.

Pushbuttons

There are 20 pushbuttons on each DDI which are used to select the function and the mode for proper indicator display.

Fault Indicator

The indicator displays unit operational status. White is failed, black is normal.

DDI MENU DISPLAYS

The DDI menu displays options (figure 1-17) are selected by pressing the MENU pushbutton (center bottom pushbutton). The desired display can then be selected by pressing the corresponding option pushbutton. Some of the options on the MENU display are conditional and are not always displayed. FLIR, LDT and CAM are listed only if the equipment is communicating with the mission computer. A/G WPN (walleye, maverick, and HARM weapons) is displayed only when the mission computer has determined from the armament control processor set that a weapon station has been selected which contains one of these weapons. LINK 4 is displayed only while an automatic carrier landing (ACL), vector (VEC), or precision course direction (PCD) data link is selected. If the

DDI Menu Display

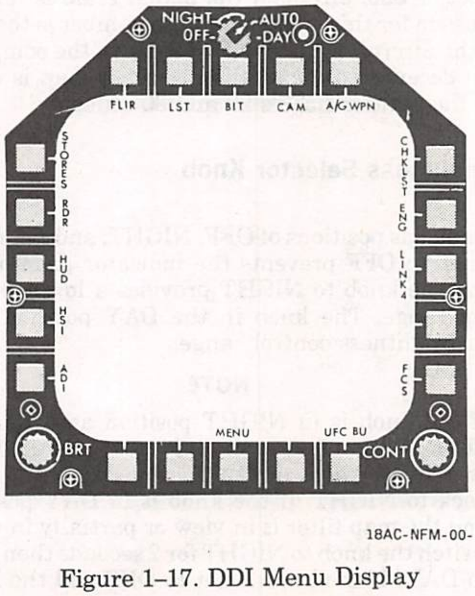


Figure 1-17. DDI Menu Display

navigation computer (MC1) is not on, CHKLST and ENG will not be displayed. If the weapon delivery computer (MC2) is not on, ADI, STORES, LDT, and CAM will not be displayed. If both mission computers are off, or not communicating with the display, the MENU display will not display a flashing STANDBY in the center of the screen.

HORIZONTAL INDICATOR (HI)

During normal operation, the HI provides aircraft attitude, steering, and navigation information with a projected moving map display superimposed over the HI display. The HI receives symbol generation and control signals from the left DDI under mission computer control. The description of the controls, pushbuttons, and indicator for the HI are the same as for the right and left DDI's except that the HI also has a mode selector knob, an HI brightness selector knob, a slew pushbutton, and a map brightness knob.

Mode Selector Knob

The mode selector knob has positions of DATA, N–UP, NORM, and D–CTR. Placing the knob to DATA selects the index frame of the moving map display and enables the upfront control for entering the desired data frame number. The index provides a listing of data available on each frame. After a data frame has been selected the film can be stepped to adjacent frames by using the up arrow and down arrow pushbuttons on the HI. Selecting N–UP on the mode selector knob rotates the map to true north up. The lubber line remains on the aircraft's magnetic heading and the ground track is magnetic ground track. Placing the knob to NORM position selects track–up display. The compass card is rotated to aircraft magnetic ground track. The aircraft symbol and the lubber line are at the aircraft magnetic heading. With the mode selector knob set to D–CTR, decentered track–up display is selected with the aircraft symbol at the bottom of the display. The aircraft symbol and the lubber lines are at the aircraft magnetic heading. When the decentered mode is selected, the range scale at top center is doubled to indicate 20, 40, 80, 160, or 320, although the actual scale is unchanged. The reason for this is that the scale number is the distance from the aircraft symbol to the inside of the compass rose. In the decentered mode, the projected map is displayed when the scale indicates 20 and 80 miles.

HI Brightness Selector Knob

The knob has positions of OFF, NIGHT, and DAY. Placing the knob to OFF prevents the indicator from operating. Placing the knob to NIGHT provides a lower brightness control range. The knob in the DAY position provides higher brightness control range.

NOTE

> If the knob is in NIGHT position and the map filter is out of view or only partially in view, switch the knob to DAY for 2 seconds and then back to NIGHT. If the knob is in DAY position and the map filter is in view or partially in view, switch the knob to NIGHT for 2 seconds then back to DAY. If the knob is set to OFF and the DAY position is desired, switch from OFF to DAY in less then ½ second.

Slew Pushbutton

Momentarily pressing the slew pushbutton assigns the designator control (TDC) on the throttle to the HI map for slewing. The map slew function is used for position updating and waypoint entry as well as to look at off–scale regions of the map. The word SLEW is displayed in the upper right corner of the HI while the TDC is assigned to the HI for map slewing. When the TDC is pressed to slew the map (other than for a map position update), the aircraft, tacan, and waypoint symbols, and the tacan and waypoint pointers are blanked from the display.

Map Brightness Knob

This knob varies the brightness intensity of the moving map display.

HI SCALE PUSHBUTTON

The HI scale pushbutton is at the top center of the HI. The pushbutton selects the range scale (10, 20, 40, 80, or 160 nautical miles). The scale is the distance from the aircraft symbol to the inside edge of the compass rose. Successive depressions of the pushbutton cause the range scale to decrement and then to start over at 160 miles. The 500,000:1 map is displayed when the 10 mile range scale is selected, and the 2,000,000:1 map is displayed when the 40 mile scale is selected. The projected map is not displayed when the other range scales are selected.

HEAD–UP DISPLAY

The head–up display (HUD) is on the center main instrument panel. The HUD is used as the primary flight instruments, weapon status, and weapon delivery display for the aircraft under all selected conditions. The HUD receives attack, navigation, situation, and steering control information from the left or right DDI symbol generators (under mission computer control), and projects symbology on the combining glass for head–up viewing. The HUD is electrically interfaced with the upfront control. The controls for the HUD are below the upfront control and are described in the following paragraphs.

HUD Symbology Reject Switch

This three–position toggle switch has positions of NORM, REJ 1, and REJ 2. With the switch placed to NORM, the normal amount of symbology is provided for all HUD displays. Placing the switch to REJ 1 removes aircraft mach number, aircraft G's, bank angle and pointer, airspeed box, altitude box, and peak positive G from the HUD. Placing the switch to REJ 2 removes all REJ 1 symbology plus the heading scale, heading caret, command heading, and nav/tacan range.

HUD Symbology Brightness Control

This knob is used to turn on the HUD and then varies the display intensity.

HUD Symbology Brightness Selector Knob

This is a three–position toggle switch with positions of DAY, AUTO, and NIGHT. Placing the switch to DAY provides maximum symbol brightness in conjunction with the HUD symbology brightness control. Placing the switch to AUTO allows automatic control of the contrast by the automatic brightness control circuit. With the switch set to NIGHT, a reduced symbol brightness is provided in conjunction with the HUD symbology brightness control.

AOA Indexer Control

This knob controls the brightness of the indexer lights.

Altitude Switch

This is a two–position toggle switch with positions of BARO and RDR. This switch is used to select either radar altitude (RDR) or barometric altitude (BARO) for display on the HUD, and as the primary altitude source for the mission computer.

Attitude Selector Switch

This three–position toggle switch has positions of INS, AUTO, and STBY. Placing the switch to INS selects unfiltered INS data as the source of attitude information for the mission computer and displays. Placing the switch to AUTO selects filtered INS data as the primary source of attitude information. The INS automatically reverts to attitude heading reference system (AHRS) using unfiltered data if its processor fails. The mission computer automatically selects the standby attitude indicator for attitude information if the INS fails completely. Placing the switch to STBY selects the attitude reference indicator as the source of attitude information for the mission computer and displays.

Fault indicator

The fault indicator indicates unit operational status. White is fail and black is normal.

NAVIGATION MASTER MODE

The navigation (NAV) master mode is entered automatically when power is applied to the aircraft, when the air–to–air (A/A) or air–to–ground (A/G) modes are deselected or when the landing gear is down. In the navigation master mode, the HUD symbology is navigation oriented. The HUD symbology includes basic flight data, advisory data, and steering and landing data.

HUD Basic Flight Data Symbology

The basic flight data presented on the HUD is shown in figure 1–19.

a. Heading. The aircraft's magnetic heading is indicated by the moving 360° heading scale. The actual aircraft heading is directly above the caret. The moving heading scale provides trend information during turns. As the aircraft turns right, the scale moves from right to left.

b. Airspeed. Calibrated air speed from the air data computer is provided in the box on the left side of the HUD. The tops of the airspeed and altitude boxes are positioned at the aircraft waterline (4° up from the optical center of the HUD).

c. Altitude. The altitude presented in the box on the right side of the HUD may be either barometric altitude or radar altitude depending on the setting of the altitude switch on the HUD control panel. When the altitude switch is in the BARO position, barometric altitude is displayed. When the altitude switch is in the RDR position, radar altitude is displayed and is identified by an R next to the altitude. If the radar altitude is invalid, barometric altitude will be displayed and a B next to the altitude flashes to indicate that barometric altitude is being displayed rather than radar altitude. The thousand and ten thousand digits are 150 percent size numbers. The hundred, ten, and unit digits are 120 percent size numbers, except that below 1000 feet they are 150 percent size.

d. Barometric setting. The barometric setting used by the air data computer (ADC) is the value set in the standby altimeter. When the barometer setting is changed on the standby altimeter, the ADC barometric setting is presented below the altitude on the HUD to provide a head–up baro–set capability. The display remains for 5 seconds after the change is made. In addition, the baro–set value is displayed and flashed for 5 seconds when the aircraft descends below 10,000 feet at an airspeed less than 300 knots.

e. Angle of attack. True angle of attack in degrees is displayed at the left center of the HUD. The primary angle of attack utilized by the HUD is derived from the angle of attack probes by the ADC. Should a probe mismatch or some other cause invalidating the probe angle of attack occur, the angle of attack source to the HUD is switched from the ADC to the flight computer.

f. Mach number. The aircraft mach number is displayed immediately below the angle of attack.

g. Aircraft G's. Normal acceleration of the aircraft is displayed immediately below the mach number.

h. Peak aircraft G's. A peak positive G indication is displayed on the HUD below the normal G anytime a threshold of 4.0 G's is exceeded. The peak positive G display can be removed by cycling the clutter reject switch to one of the reject positions.

i. Bank angle scale. A bank angle scale and pointer are displayed at the bottom of the HUD for bank angle reference up to 45°. At bank angles in excess of 47°, the bank angle scale pointer is limited at 45° and flashed.

j. Velocity vector. The velocity vector provides the pilot with an outside world reference with regard to actual aircraft flight path. The velocity vector represents the point towards which the aircraft is flying (aircraft flight path). The position of the velocity vector is limited to an 8° radius circle centered at the HUD optical center. If the velocity vector reaches this limit during high angle of attack flight or large yaw and/or drift angles, then it flashes rapidly to indicate that it does not accurately indicate flight path. If INS velocity data becomes unreliable the mission computer utilizes air data computer information and the last available wind data to compute the velocity vector and this degraded velocity vector is indicated by a slow flashing of the symbol. In the NAV master mode, the velocity vector may be caged to the vertical center line of the HUD by the cage/uncage switch on the throttle. When it is caged, a ghost velocity vector is displayed at the true velocity vector position if that position is more than 2° from the caged position. The flight path/pitch ladder and steering information are referenced to the caged position. The ghost velocity vector will flash when limited.

k. Flight path/pitch ladder. The vertical flight path angle of the aircraft is indicated by the position of the velocity vector on the flight path/pitch ladder. The horizon and flight path/pitch angle lines represent the horizon and each 5° of angle between plus and minus 90°. Positive pitch lines are solid and are above the horizon line. Negative pitch lines are dashed and are below the horizon line. The outer segments of the lines point toward the horizon. Each line is numbered and the numbers rotate with the lines so that inverted flight can easily be determined. To aid in determining flight path angle when it is changing rapidly, the pitch lines are angled toward the horizon at an angle half that of the flight path angle. For example, the 50^{O} pitch line is angled 25^{O} toward the horizon. In level flight, the pitch lines are not angled. The zenith is indicated by a circle and the nadir is indicated by a circle with an X in it. Aircraft pitch angle can be determined by comparing the tops of the altitude and airspeed boxes (which represent the aircraft waterline) with the pitch ladder when the wings are level. However, since the flight path/pitch ladder normally rotates about the velocity vector, determination of pitch angle may be difficult at high roll angles.

HUD Advisory Data Symbology

The displays in figure 1–19 show some of the advisories that can appear on the HUD in the NAV master mode. The advisories are associated with the autpilot, nose wheel steering, and approach power compensator. Although the advisories are shown on the gear down display, most of them can appear on the basic HUD display. Refer to Section VIII for description of data link system and advisories.

a. The autopilot advisories (HH, HSEL, ATTH, RALT, BALT) are negative advisories. When autopilot modes are disengaged due to any reason other than actuation of the paddle switch or the upfront control option switches, the appropriate advisories are displayed and flashed for 10 seconds.

b. The flashing negative cues for non–pilot initiated disengagement of HH, HSEL, ATTH, RALT, and BALT, may be removed from the HUD by actuation of the autopilot disengage (paddle) switch on the flight control stick.

c. The automatic throttle control/nosewheel steering advisories are displayed above the distance display whenever the ATC or the NWS is engaged. If the ATC is disengaged by any means other than actuation of the ATC engage/disengage switch, the advisory is flashed for 10 seconds before it is removed from the display or, if a pilot attempt to engage ATC is not successful, then ATC is flashed for 10 seconds then removed.

HUD Landing Symbology

Figure 1–19 shows the landing display which is presented on the HUD when the landing gear is down.

a. When the landing gear is down, the Mach number, G's and peak G's are deleted and the horizon bar is extended across the display.

b. The center of the AOA bracket represents the optimum approach angle of attack. The bracket moves lower with respect to the velocity vector as AOA increases, and it moves higher as AOA decreases.

c. Rate of climb/descent (altitude rate of change in feet per minute) is displayed above the altitude only in the navigation master mode and only with landing gear down. Descent is indicated by negative values.

d. The waterline symbol is displayed with the landing gear down.

HUD BIT CHECKS

The HUD has two methods of built–in tests: manually initiated and automatic test. Refer to Section I, Status Monitoring Subsystem, figures 1–28 and 1–29 for the procedures and displays used for the HUD BIT checks.

COURSE SET SWITCH

The course set switch manually sets the desired course on the HI display.

HEADING SET SWITCH

The heading set switch manually sets the heading marker on the desired heading on the HI display.

UPFRONT CONTROL

The upfront control (UFC) (figure 1–18) is on the main instrument panel below the HUD. The UFC is used to select autopilot modes and control the IFF, tacan, ILS, data link, radar beacon, UHF radios and ADF. The UFC is used in conjunction with the two DDI's and the HI to enter navigation, sensor, and weapon delivery data. UFC option selections and inputs are primarily transmitted directly to the communication system control for discrete control of the CNI equipment or for routing to the mission computers. Refer to Section VII for operating instructions to CNI equipment. A description of the UFC switches and displays follows.

Brightness Control Knob

The knob has positions of BRT (bright) and DIM. The brightness of the display increases as the knob is rotated clockwise toward BRT.

Upfront Control (UFC)

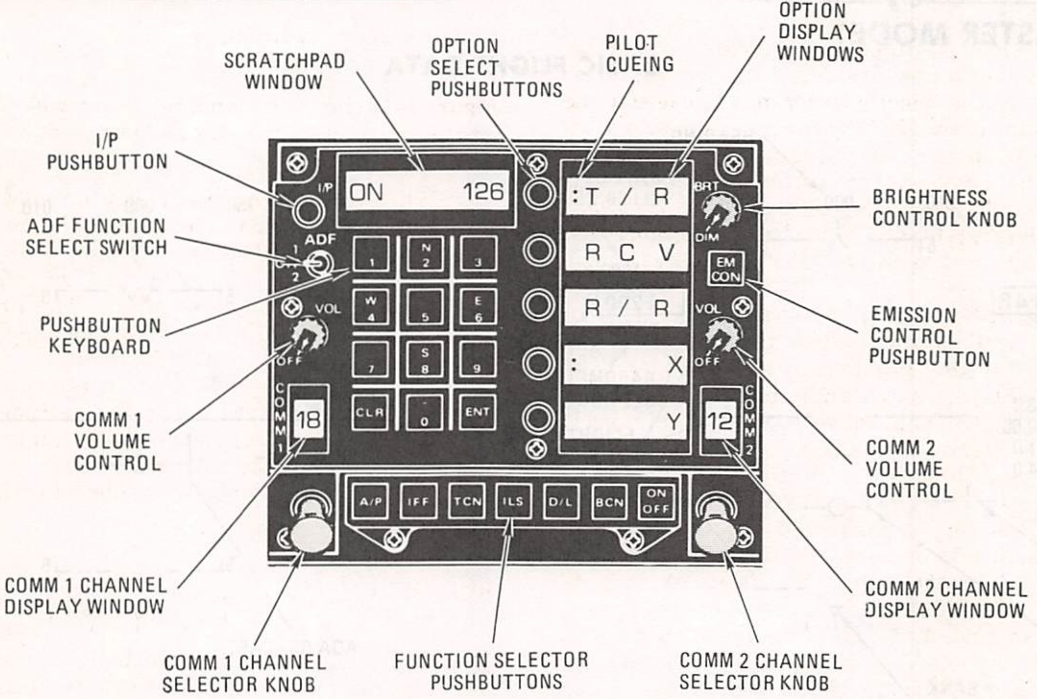


Figure 1-18. Upfront Control (UFC)

Emission Control Pushbutton

This pushbutton is labeled EM CON. Pushing the button to the ON position inhibits IFF, tacan, radar beacon, radar altimeter, two–way data link, and walleye from transmitting. The letters E, M, C, O, and N are displayed in a vertical column in the five option windows when EM CON is selected. With the pushbutton pushed to OFF, the transmitters are permitted to radiate.

I/P Pushbutton

Pushing this momentary pushbutton causes the IFF to respond to mode 1, 2, and 3 interrogations with identification of position response.

ADF Function Select Switch

Pushing this switch to the 1 position selects comm 1 for ADF operation. In the OFF position ADF is disabled. In the 2 position comm 2 is selected for ADF operation.

Option Select Pushbuttons

The five pushbuttons select or deselect the displayed options.

Pilot Cueing

A colon (:) is displayed when an option is selected. The colon disappears when an option is deselected.

Option Display Windows

The option display windows display five options of four alphanumeric characters each that are available for selection.

Scratch Pad Window

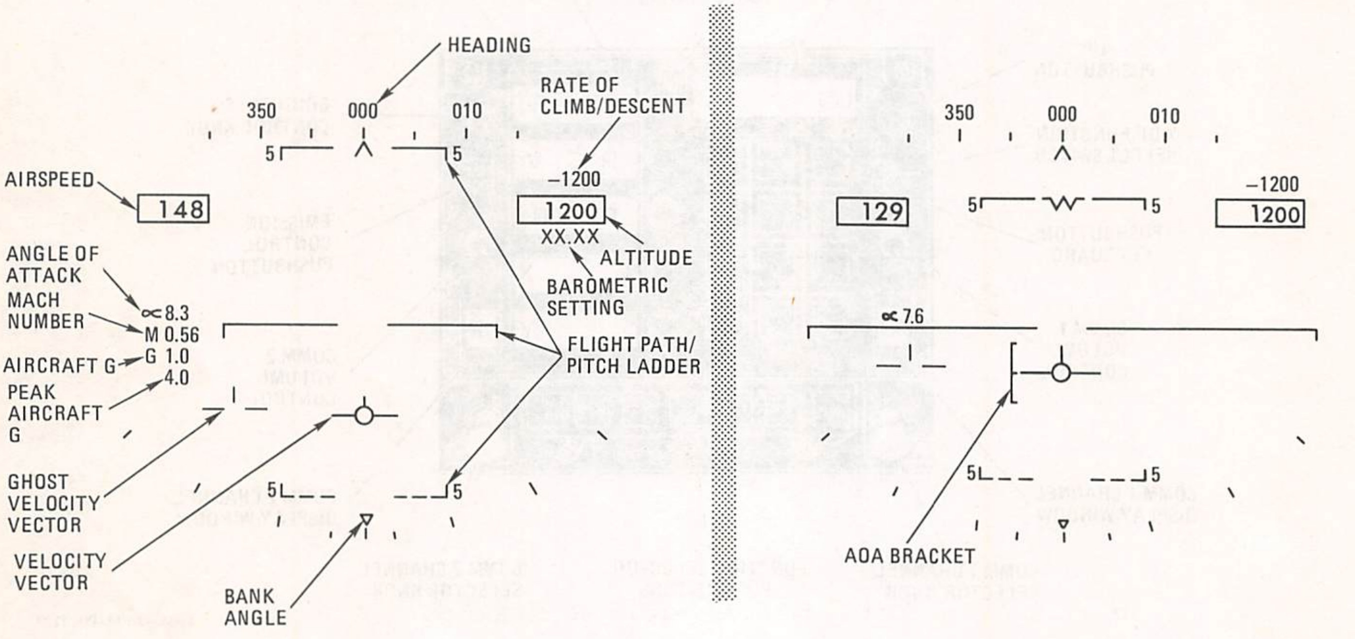
The scratch pad window displays keyboard entries on a 9–character readout. The first two characters are alphanumeric and the other 7 are numeric.

Pushboard Keyboard

The pushbutton keyboard contains alphanumeric pushbuttons, a CLR (clear) pushbutton, and an ENT (enter) pushbutton. Pressing the alphanumeric pushbutton enters a corresponding alphanumeric as digital information into the control converter. The number or letter of the pressed button is displayed on the right end of the scratch pad. The number or letter moves to the left as additional numbers are entered. The decimal point or degree/minute symbols are automatically displayed in correct position for information being entered. Trailing zeroes must be entered. Pressing the

HUD Symbology
(NAV MASTER MODE)

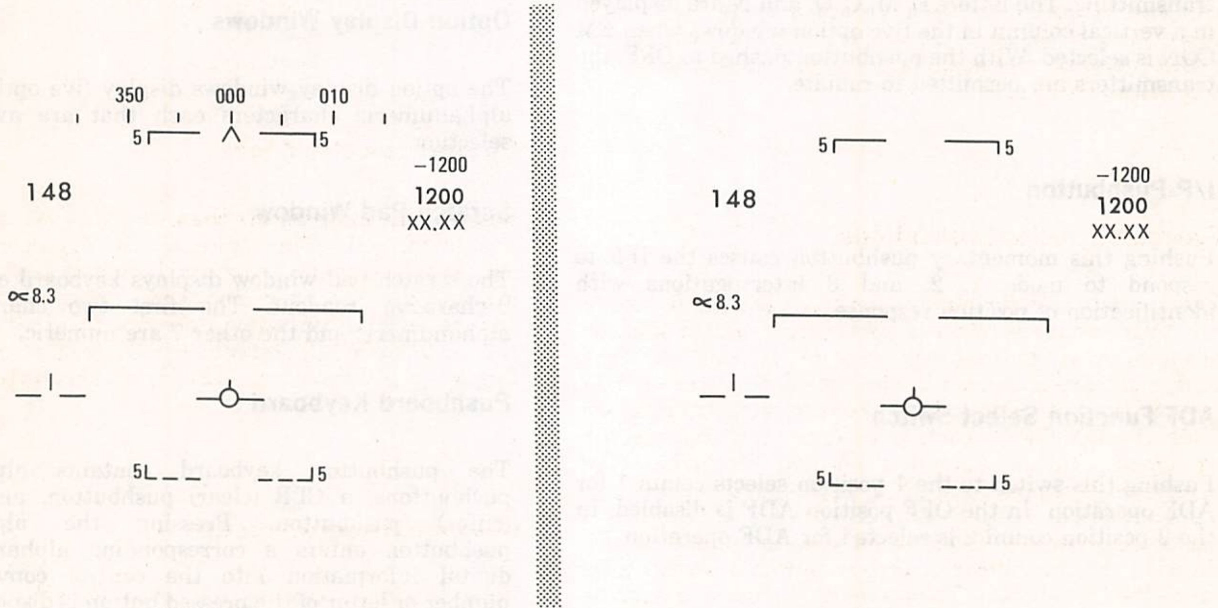
BASIC FLIGHT DATA



GEAR HANDLE UP

GEAR HANDLE DOWN

SYMBOLOGY REJECTION



REJECT 1

REJECT 2

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Figure 1-19. Hud Symbology (Sheet 1 of 2)

HUD Symbology

(NAV MASTER MODE)

ADVISORY DATA

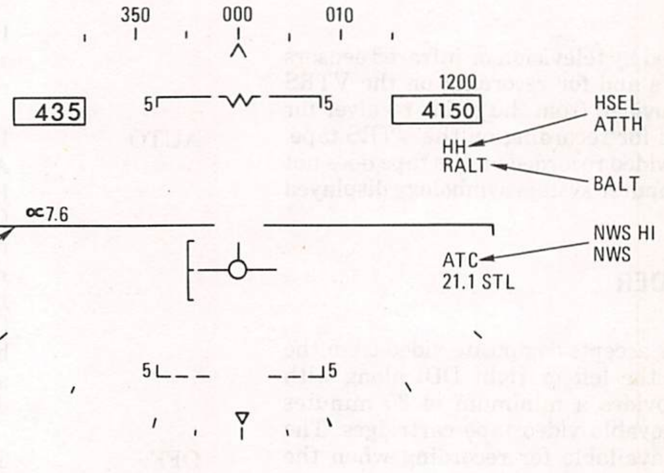

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Figure 1-19. Hud Symbology (Sheet 2 of 2)

CLR pushbutton clears the scratch pad and/or the option display windows. Pressing the CLR pushbutton once clears the scratch pad, pressing it a second time clears the option display windows. Pressing the ENT pushbutton causes the keyboard entry displayed in the scratch pad to be sent to the control converter to change operation of selected equipment or to make data available to the mission computer. If entry via the keyboard is valid, the scratch pad display blinks once. If entry is invalid, the word error appears and flashes in the scratch pad display until the scratch pad is cleared.

Function Selector Pushbuttons

The function selector pushbuttons for the equipment are mutually exclusive. When a particular function selector pushbutton is pressed, the control options for that equipment are displayed in the option windows (and in case of the autopilot switch, the autopilot is engaged). Then the ON–OFF switch is used to turn the selected equipment (except autopilot) on and off. When the equipment is on, the word ON is displayed in the first two alphanumerics of the scratch pad. The first two alphanumerics are blank when the equipment is off. Pressing the function selector pushbutton a second time clears the UFC display. The pressing of a function selector pushbutton, the pulling of a channel selector knob, or the receipt of a UFC mode command from the mission computer will terminate all prior activity (but with all previous entries retained) and will present the options for the newly selected mode.

Volume Controls

Turning the volume control to the OFF position turns off the corresponding radio. The comm 1 and comm 2 channel display windows illuminate if the respective radios are on. Out of the OFF position, the knob controls the audio volume for the corresponding radio.

Channel Selector Knobs

Rotating the knob selects channel 1 thru 20, manual (M), or guard (G). The channel is displayed in the corresponding comm 1 or comm 2 channel display window. Pulling the spring–loaded knob causes the selected channel and its frequency to be displayed in the scratch pad and enables the control converter to change the frequency of the selected channel via the keyboard entry.

Channel Display Windows

When the corresponding radio is on, the selected channel (1-20, M or G) is displayed on the 16 segment alphanumeric display window. The diagonal display segment in the lower right quadrant of each display window illuminates whenever transmissions are received on comm 1 and comm 2, respectively.

VIDEO TAPE RECORDING SYSTEM

The video tape recording system (VTRS) consists of a video tape recorder and a HUD video camera. In addition, the system utilizes other existing airplane equipment.

DDI VIDEO

Weapon video is provided by television or infrared sensors for display on the DDI's and for recording on the VTRS tape. Radar video is provided from the radar receiver for display on the DDI and for recording on the VTRS tape. The weapon and radar video recorded on the tape does not include the mission computer system symbology displayed on the DDI.

VIDEO TAPE RECORDER

The video tape recorder accepts composite video from the HUD video camera or the left or right DDI along with headset audio, and provides a minimum of 30 minutes recording time on removable video tape cartridges. The headset audio is only available for recording when the KY–58 encryption function is inactive.

HUD VIDEO CAMERA

The HUD video camera (HVC) provides real–time conversion to a television scan format of the HUD display superimposed on the image of the outside world. The HUD imagery and outside world is sensed via optics and the resultant composite video output is made available to the video tape recorder. The switches for operating the VTRS are on the HUD video camera control panel.

HUD VIDEO CAMERA CONTROL PANEL

The HVC control panel contains a HUD/DDI selector switch, a mode selector switch, a BIT initiate pushbutton, and go/no–go indicators.

HUD/DDI Selector Switch

The HUD/DDI selector switch has positions of HUD, L DDI, and R DDI.

HUD	Head–up display imagery superimposed on the outside world is recorded.
L DDI	The radar or weapons video supplied to the left DDi is recorded.
R DDI	Information supplied to the right DDI same as left DDI and recorded.

Mode Selector Switch

The mode selector switch has positions of MAN, AUTO, and OFF.

MAN	In the manual mode the VTRS is recording continuously. The HUD/DDI selector switch can be set to the desired position for recording.
AUTO	If the airplane is operating in the A/A or A/G master mode, the HUD video camera and the video tape recorder run continuously and records whatever is selected on the HUD/DDI selector switch. However, if the first detent on the trigger or the weapon release button is pressed, the VTRS automatically records the HUD display.
OFF	The VTRS is inoperative.

When the HUD video is being recorded as a result of a trigger switch or weapon release button actuation, the HUD video continues to be recorded for a preset overrun time after the control is released. For sidewinder launches and gun firing, the overrun time is 5 seconds. For sparrow launches and A/G weapon releases, the overrun time is 10 seconds.

BIT Initiate Pushbutton

The pushbutton is pressed to test the HUD video camera. The GO and NO GO balls are normally black. If the BIT test is good, the Go ball will show green. If the BIT test is not good the NO GO ball will show orange.

EVENT MARK

When the weapon release button is pressed, an event mark signal is supplied to the HUD video camera. At that time a black box is generated by the camera and appears in the upper left corner of the video signal going to the video tape recorder. When the trigger is actuated to the second detent position to launch a missile, the event mark is generated and recorded until the trigger is released.

RECORDER ON LIGHT

The RCDR ON light, on the right warning/caution/advisory lights panel comes on when the recording system is recording.

FIRE DETECTION/EXTINGUISHING SYSTEMS

The fire detection and extinguisher system is made up of three fire warning/extinguisher lights, a fire extinguisher pushbutton, one fire extinguisher bottle, a fire test switch and dual–loop fire detection sensors. The extinguisher bottle is in the aft fuselage between the engines. The bottle contains a nontoxic gaseous agent which provides a one–shot extinguishing capability. Direct current electrical power (essential 24/28 volt dc and engine start 24/28 volt dc buses) is required to operate the system. The systems operate on battery power with the battery switch in either ON or ORIDE. The systems provide engine/AMAD and APU fire warning, emergency shutdown and selective fire extinguishing.

FIRE WARNING/EXTINGUISHER LIGHTS/VOICE ALERT

The three fire warning/extinguisher lights are pushbutton switch indicators which come on when a fire condition exists. Two of the fire warning/extinguisher lights are labeled FIRE, one is mounted on the top left corner and the other on the top right corner of the instrument panel. The two FIRE warning/extinguisher lights are guarded. The left FIRE light indicates a fire condition in the left engine bay. The right FIRE light indicates a fire condition in the right engine bay. The APU FIRE light is positioned inboard of the right FIRE light. It indicates a fire condition in the auxiliary power unit bay. A voice alert warning is activated anytime a fire warning light comes on. If the left FIRE light comes on, the ENGINE FIRE LEFT voice alert is activated. If the right FIRE light comes on the ENGINE FIRE RIGHT voice alert is activated. If the APU FIRE light comes on, the APU FIRE voice alert is activated. If more than one warning light comes on at the same time, the voice alert warning priority is: ENGINE FIRE LEFT, ENGINE FIRE RIGHT, then APU FIRE.

FIRE EXTINGUISHER PUSHBUTTON

The fire extinguisher pushbutton switch is on the master arm panel and is labeled FIRE EXTGH. The switch has two lights. A yellow light labeled READY and a green light labeled DISCH (discharge). When READY is on, the fire extinguisher bottle is armed. The READY light comes on when the appropriate fire warning/extinguisher light is pressed. Pressing an engine fire warning/extinguisher light shuts off fuel to the engine at the feed tank. With READY on, pressing the fire extinguisher pushbutton discharges the fire extinguisher bottle and turns on the DISCH light. There is no indication of actual discharge of the fire extinguisher bottle.

APU FIRE EXTINGUISHING SYSTEM

The APU fire extinguishing system can be either manually or automatically actuated. To manually actuate the system, the fire extinguisher bottle is first armed and the APU shutdown by pressing the APU FIRE warning/extinguisher light. The extinguisher bottle is then discharged into the APU bay by pressing the FIRE EXTGH pushbutton with the READY light on. Discharge of the bottle is delayed 10 seconds after the light is pressed. This allows the APU time to spooldown before the extinguishing agent is introduced. If on the ground, the APU fire extinguishing system is actuated automatically. The result is the same as with manual actuation, with the APU shutting down immediately after a fire is detected and the fire extinguisher discharging into the APU bay 10 seconds later. The automatic system is prevented from operating during flight by the action of a weight–on–wheels relay.

ENGINE/AMAD FIRE EXTINGUISHING SYSTEM

Actuation of the engine/AMAD fire extinguishing system can only be performed manually.

The system is armed by lifting the guard and pressing the affected FIRE warning/extinguisher light. This also shuts off fuel to the engine at the feed tank or shuts down the APU. The extinguisher bottle is discharged into the affected engine bay by pressing the FIRE EXTGH pushbutton with the READY light on.

FIRE AND BLEED AIR TEST SWITCH

Each of the three warning/extinguisher lights contains four individual light bulbs which are simultaneously tested by actuation of the lights test switch on the interior lights panel. Operation of the lights test switch tests only the light bulbs in the warning/extinguisher lights and requires ac electrical power on the aircraft. The fire/bleed air leakage detection sensors and associated circuits are tested by the fire and bleed air test switch. Operation of the fire and bleed air test switch requires power on the essential 24/28 volt dc bus. The fire and bleed air switch is on the fire test panel on the left console. When actuated to TEST A or TEST B, the fire warning, bleed air leak detection and voice alert warning circuitry for the designated loop is tested. If a malfunction exists in a fire detection loop associated with APU FIRE warning/extinguisher light, none of the four individual bulbs in the indicator come on. If a malfunction exists in a fire detection loop associated with either FIRE warning/extinguisher light, only the individual bulb (or bulbs) associated with the malfunctioning sensor will not come on. Care must be taken to detect bulbs that are not on in the FIRE warning/extinguisher during the loop test. Switch actuation also turns on the L BLEED and R BLEED warning lights and the L BLD OFF and R BLD OFF caution displays while the switch is activated and closes the left and right bleed air pressure regulator and shutoff valves indicating the designated loop bleed air detection sensors and circuitry are operational. The L(R) BLEED warning lights go out after the switch is released to NORM. The L(R) BLD OFF caution displays remain on until the valves are reopened. To open the valves after test, there must be ac power on the aircraft and the bleed air knob must be rotated through OFF to NORM.

NORM	System provides normal fire and bleed air leak warning. Switch is spring loaded to this position.
TEST A	Turns on the 3 fire warning/extinguisher lights, activates the voice alert, turns on the 4 bleed air lights, indicating that loop A fire detection sensors and circuitry are operational.
TEST B	Turns on the 3 fire warning/extinguisher lights, activates the voice alert, turns on the 4 bleed air lights, indicating that Loop B fire detection sensors and circuitry are operational.

During TEST A or B, the ENGINE FIRE LEFT voice alert warning is activated first. If the switch is held in the TEST position, the sequence will be as follows: ENGINE FIRE LEFT, ENGINE FIRE RIGHT, APU FIRE, BLEED AIR LEFT, then BLEED AIR RIGHT.

ENTRANCE/EGRESS SYSTEMS

CANOPY SYSTEM

The cockpit area is enclosed by a clamshell type canopy. The main components of the canopy system are an electromechanical actuator which provides powered and manual operation of the canopy, and a cartridge actuated thruster with associated rocket motors for emergency jettison. Latching provisions consist of three latch hooks on the bottom of each side of the canopy frame and two forward indexer pins on the lower leading edge of the canopy frame. When the canopy is closed, the latch hooks and indexer pins engage fittings along the canopy sill and the canopy actuator rotates the canopy actuation link over–center, locking the canopy. A mechanical brake in the canopy actuator motor provides a redundant lock. An inflatable seal, installed around the edge of the canopy frame, retains cockpit pressure when the canopy is locked. A rain seal is installed outboard of the pressure seal to divert rain water away from the cockpit.

NORMAL CANOPY SYSTEM

Normal canopy operation is provided by the internal canopy control switch (figure 1–20) on the right side of the cockpit under the canopy sill. An external canopy control switch provides powered operation of the canopy from outside the aircraft. With no generator or external electrical power on the aircraft, battery power is available for at least five open/close cycles of the canopy. If no electrical power is available for canopy operation, a back–up crank system is provided to manually power the canopy actuator. Internally, the manual crank is under the left canopy sill. Externally, manual handcrank provisions are provided by a drive socket located flush on the mold line, outside of the internal handcrank. Internally, 70 counterclockwise crank turns are required to fully open the canopy; externally, 35 counterclockwise crank turns are required.

Internal Canopy Switch

The internal canopy switch has three positions: OPEN, CLOSE and HOLD.

OPEN	Raises canopy to maximum open position. If selected when canopy is locked, the canopy will first unlock, then move 1.5 inches aft before rising. The OPEN position is solenoid–held until the maximum up position is reached, after which it is spring loaded to the HOLD position. The solenoid can be overridden at any time by placing the switch to HOLD. To prevent inadvertant loss of canopy, the OPEN solenoid is wired through the weight on wheels switches so that it is inoperative during flight.
HOLD	Will stop the canopy at any point during the open or close cycle.
CLOSE	Lowers canopy. If held after canopy reaches canopy sill, canopy moves forward 1.5 inches and then locks. Locked condition indicated by MASTER CAUTION light and CANOPY display going out. CLOSE position is spring loaded to the HOLD position.

External Canopy Switch

Electrical operation of the canopy from outside the cockpit is provided for by the external canopy switch inside the external power receptacle door (Door 9) on the left side of the aircraft below the canopy and LEX. The door is equipped with a quick release latch. The switch contains the same positions and operates identically to the internal canopy switch, except that the OPEN position is not solenoid–held.

Internal Manual Canopy Handcrank

A manual canopy handcrank is provided to manually open the canopy. The handcrank, under the left canopy sill, opens the canopy when the crank handle is turned approximately 70 turns in a counterclockwise direction.

Canopy Controls

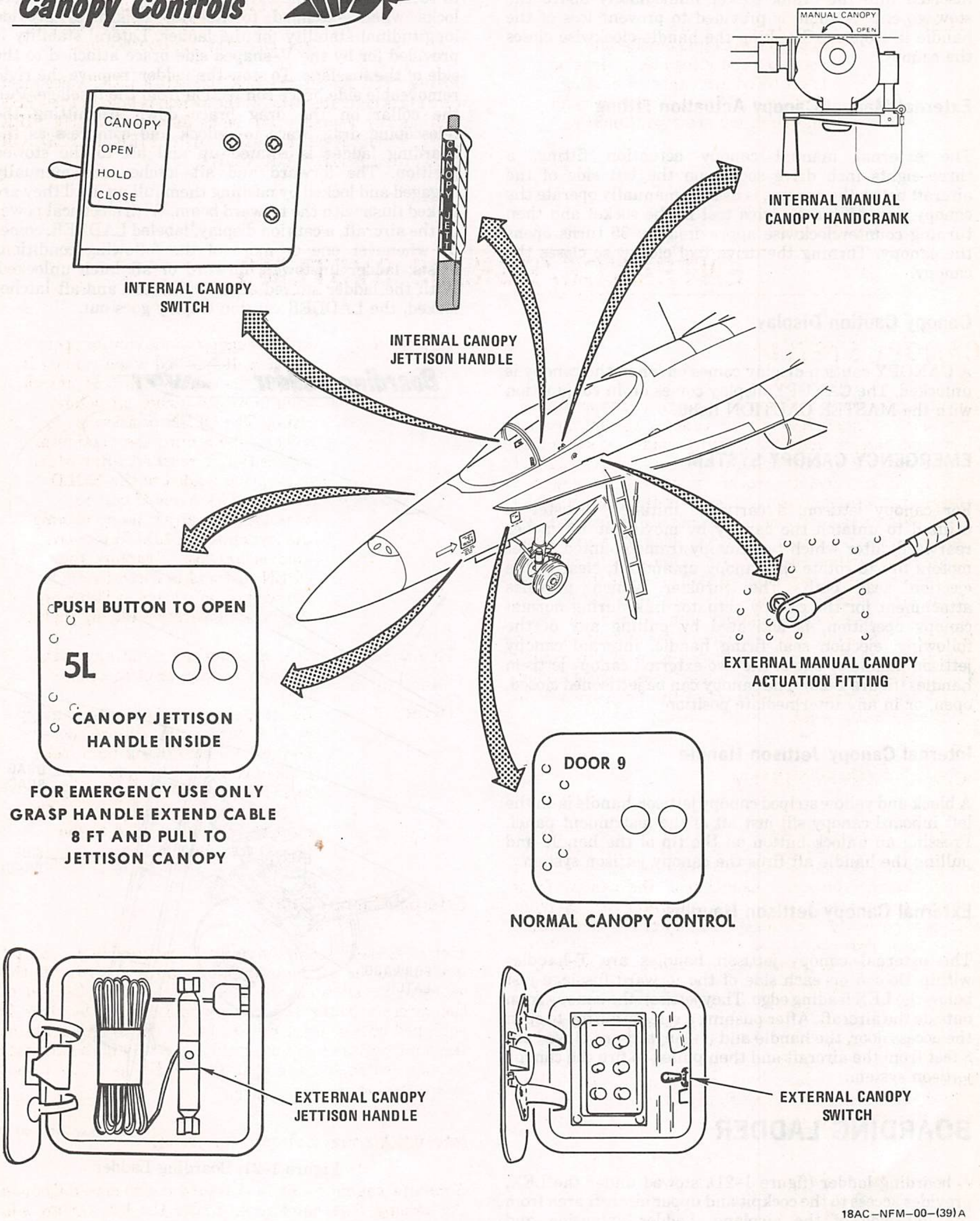

Figure 1–20. Canopy Controls

Before use, the handcrank handle must be unstowed by removing it from a stowage clip and socket and then inserted into the crank socket immediately above the stowage clip. A cable is provided to prevent loss of the handle if dropped. Cranking the handle clockwise closes the canopy.

External Manual Canopy Actuation Fitting

The external manual canopy actuation fitting, a three-eighths inch drive socket on the left side of the aircraft below the canopy, is used to manually operate the canopy. Inserting a ⅜ drive tool in the socket and then turning counterclockwise approximately 35 turns opens the canopy. Turning the drive tool clockwise closes the canopy.

Canopy Caution Display

A CANOPY caution display comes on when the canopy is unlocked. The CANOPY display comes on in conjunction with the MASTER CAUTION light.

EMERGENCY CANOPY SYSTEM

For canopy jettison, a cartridge initiated thruster is utilized to unlatch the canopy by moving it 1.5 inches rearward, after which two canopy framemounted rocket motors fire to rotate the canopy up and aft, clear of the ejection seat path. The thruster, which provides attachment for the canopy actuator link during normal canopy operation, is activated by pulling any of the following: ejection seat firing handle, internal canopy jettison handle or one of the two external canopy jettison handles (figure 1-20). The canopy can be jettisoned closed, open, or in any intermediate position.

Internal Canopy Jettison Handle

A black and yellow striped canopy jettison handle is on the left inboard canopy sill just aft of the instrument panel. Pressing an unlock button on the tip of the handle and pulling the handle aft fires the canopy jettison system.

External Canopy Jettison Handles

The external canopy jettison handles are T-handles within Door 5 on each side of the forward fuselage just below the LEX leading edge. They jettison the canopy from outside the aircraft. After pushing a release button to open the access door, the handle and its lanyard are played out 8 feet from the aircraft and then pulled to fire the canopy jettison system.

BOARDING LADDER

A boarding ladder (figure 1-21), stowed under the LEX, provides access to the cockpit and upper aircraft area from the left side of the airplane. Ladder extension and retraction can only be accomplished from outside the cockpit. To extend the ladder, manually support the ladder and release the forward and aft latches on the forward beam on the underside of the LEX, permitting the ladder to rotate down to the extended position. The drag brace locks when extended to its full length to provide longitudinal stability for the ladder. Lateral stability is provided for by the V-shaped side brace attached to the side of the fuselage. To stow the ladder, remove the rigid removeable side brace connection from the fuselage. Pull the collar on the drag brace down permitting the telescoping drag brace to unlock and compress as the boarding ladder is rotated up and aft to the stowed position. The forward and aft latches are manually engaged and locked by pushing them full up until they are locked flush with the forward beam. With electrical power on the aircraft, a caution display, labeled LADDER, comes on whenever one or more of the following conditions exists: ladder unstowed, forward or aft latch unlocked. With the ladder stowed and the forward and aft latches locked, the LADDER caution display goes out.

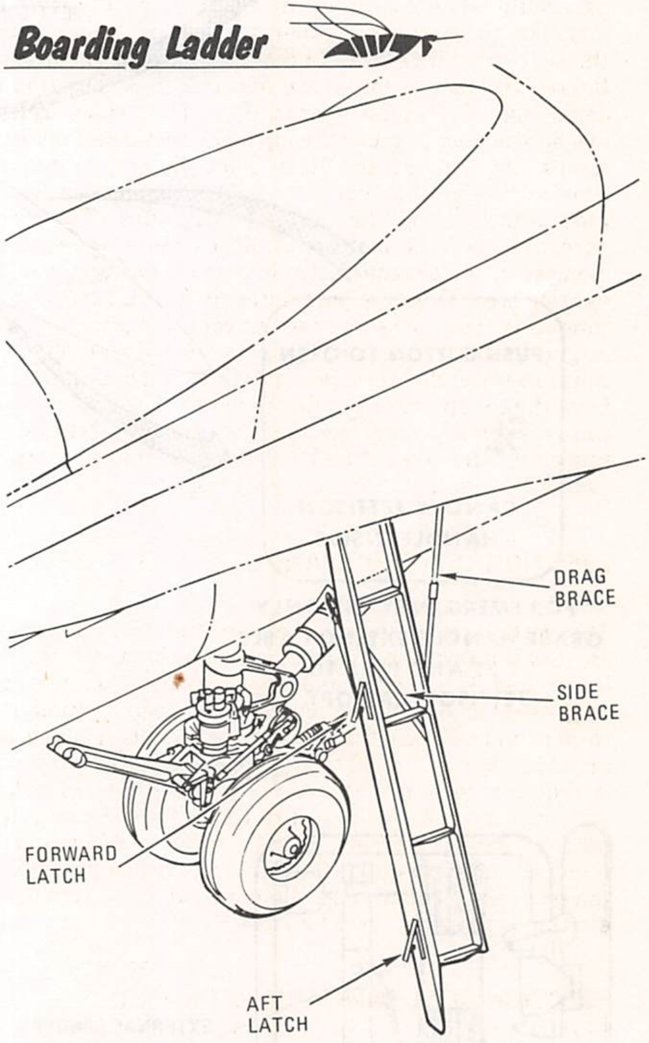

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Figure 1-21. Boarding Ladder

EJECTION SEAT

The SJU–5/A ejection seat is a ballistic catapult/rocket system that provides the pilot with a quick, safe, and positive means of escape from the aircraft. See Ejection Seat, Foldout section, for ejection seat illustration. The seat system includes an initiation system which, after jettisoning the canopy and positioning the occupant for ejection, fires the seat catapult. Canopy breakers on the top of the seat give capability for ejecting through the canopy. As the seat departs the aircraft a rocket motor on the bottom of the seat is fired. Shortly after departing the aircraft a drogue gun is fired to deploy two drogue chutes. The drogue chutes then either remain attached to the top of the seat or are released to deploy the main parachute, depending on altitude and the number of G's applied on the seat. An automatic time release mechanism, after a delay of 1.50 seconds, opens the main parachute container and releases the drogue chutes to deploy the main parachute when conditions of altitude and G forces are met. The time release mechanism does not actuate until the seat is below 14,500–11,500 feet barometric altitude. Below 7500 feet, G forces are not used as a condition for deploying the main parachute. The time release mechanism also releases the lap belt, inertia reel restraint straps, and leg restraint lines. Both the drogue gun and time release mechanism are actuated on ejection by trip rods attached to the aircraft structure. The main parachute is a 17 foot aeroconical canopy type, stored along with the drogue chutes in a container on top of the ejection seat. This type parachute gives a quicker opening time with about the same descent rate as parachutes with larger diameter canopies. The parachute is steerable, and contains water deflation pockets which aid in dumping air from the canopy after landing in water. The seat contains controls for adjusting seat height, and for locking and unlocking the inertia reel shoulder restraint straps. A survival kit is installed in the seat pan.

EJECTION CONTROL HANDLE

The ejection control handle, between the pilot's legs on the front of the seat pan, is the only means by which ejection is initiated. The handle, molded in the shape of a loop, can be grasped by one or two hands. To initiate ejection, a 15 to 40 pound pull removes the handle from its housing, and an additional pull of 30 to 40 pounds, if pulled vertically, is required to pull both sears from the dual initiators. Either of the initiators can fire the seat. If the handle is inclined forward or aft, a pull of 30 to 50 pounds is required. After ejection, the handle remains attached to the seat. The ejection control handle can be saftied by the ejection seat safe/armed handle.

EJECTION SEAT SAFE/ARMED HANDLE

To prevent seat ejection, an ejection seat safe/armed handle is provided. The handle, forward on the right seat armrest, safeties the seat when rotated up and forward, and arms the seat when it is rotated aft and down. The safe/armed handle is locked when placed to either of these two positions and the handle must be unlocked before changing positions by squeezing a locking lever within the handle cutout. When in the armed position the visible portion of the handle (from the occupant's vantage point) is colored yellow and black with the word ARMED showing. In the safe position, the visible portion is colored white with the word SAFE showing. Placing the handle to the SAFE position causes a pin to be inserted into the ejection firing mechanism to prevent withdrawal of the sears from the dual seat initiators.

SHOULDER HARNESS INERTIA REEL

Pilot shoulder harness restraint is provided by a dual strap shoulder harness inertia reel mounted in the seat below the parachute container. The dual inertia reel shoulder straps connect to the parachute risers which in turn are buckled to seat occupant's upper harness. The inertia reel locks when the reel senses excessive strap velocity. Manual locking and unlocking of the reel is controlled by the shoulder harness lock/unlock handle on the left side of the seat bucket. During ejection a pyrotechnic cartridge is fired to retract the shoulder harness to position the seat occupant for ejection.

SHOULDER HARNESS LOCK/UNLOCK HANDLE

The shoulder harness lock/unlock handle on the left side of the seat bucket has two positions. To operate, the handle must be pulled up against spring pressure, moved to the desired position, and then released.

FORWARD (locked)	The inertia reel prevents the reel straps from being extended and ratchets any slack in the straps back into the reel.
AFT (unlocked)	The reel allows the pilot to lean forward, but the inertia portion of the reel continues to protect him by locking the reel when it senses excessive strap velocity. Once locked, the pilot can normally lean forward again after a slight release in pressure on the reel straps.

LEG RESTRAINT SYSTEM

A leg restraint system is located on the front of the ejection seat. The function of the system is to secure the occupant's legs to the seat during ejection. The system consists of two adjustable leg garters, a restraint line and a snubber box for each leg. One garter is worn on the thigh and one on the lower leg, and the restraint lines are routed through the garter rings and the snubber box as shown in figure 1–22. One end of each restraint line is secured to the cockpit floor and the other, after being routed through the snubber box and both garter rings, is secured to the seat just outboard of the snubber box by a releasable pin. During ejection, the slack in each line is taken up and the tension builds up to finally separate the lines at tension rings in the leg lines. At man–seat separation, the pins on the other end of the lines are released by the time release mechanism. The pins are also released when the manual override handle is pulled. Both the lower garter and thigh garter contain a quick release buckle which disconnects the ring through which the leg restraint line runs, permitting the pilot to egress from the aircraft wearing both upper and lower garters. In addition, toe clips are installed on the tops of the rudder pedals to prevent contact between the toes and the instrument panel during ejection.

Leg Restraint Snubber Release Tabs

The leg restraint lines are adjusted to give the pilot more leg movement by pulling inboard the leg restraint snubber release tabs (figure 1-22) and simultaneously pulling the leg restraint lines forward through the snubber box.

SURVIVAL KIT

Provisions for survival after ejection or ditching are stored in the survival kit (figure 1-23). The kit is composed of a two-piece fiberglass container. The lower portion of the kit contains emergency provisions and an inflatable raft. The upper portion of the kit, containing a 50 cubic inch emergency oxygen supply, serves as the kit cover and has a seat cushion attached to the top. During ejection the emergency oxygen is tripped by an automatic oxygen operating cable lanyard attached to the cockpit floor. The kit contains an emergency oxygen green ring on the left forward part of the upper kit. A flexible oxygen and communications hose is installed in the left aft side of the upper kit to provide a connection to the pilot for ship's oxygen and communications. After ejection or after the emergency oxygen green ring is pulled, emergency oxygen is supplied to the pilot through the hose. The survival kit is secured to the seat by two lugs installed on the aft upper corners of the kit, and a lug installed through a bracket on the front of the kit. Two adjustable lap belt straps are installed on the sides of the kit. These straps connect to fittings on the pilot's lower torso harness to secure the pilot to the kit, and thus to the seat. The restraint provided by the three lugs is released by the action of the time release mechanism at seat-man separation after ejection, or by the action resulting from pulling the manual override handle. Additional restraint is provided by straps which connect the survival kit to sticker clips in the seat. The straps require a force of between 25 to 40 pounds to separate from the sticker clips at man-seat separation after ejection or during ground egress. The kit is equipped with an AN/URT-33A radio beacon locator which actuates during ejection at man-seat separation. The kit can be deployed after ejection during parachute descent by pulling the survival kit release handle on the right side of the kit. This unlocks the kit causing the lower half to fall away while remaining attached to the upper half by a dropline. The liferaft, also attached to the dropline, falls away and inflates by gravity. An equipment bag containing the other survival aids falls away but remains attached to the upper kit lid by a lanyard. Should the pilot land in water before deploying the survival kit, the liferaft can be inflated by pulling the survival kit release handle and then reaching into the kit and pulling the actuating cable on the liferaft CO_2 bottle.

Leg Restraint System

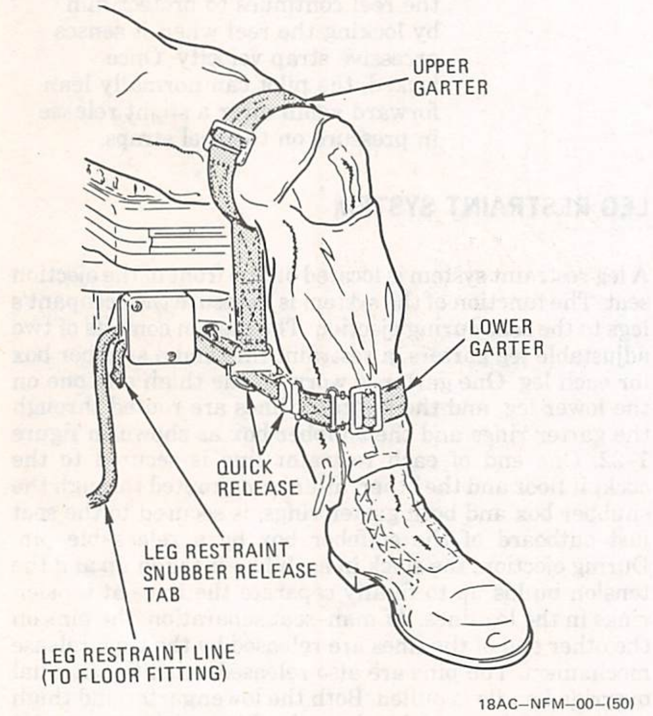


Figure 1-22. Leg Restraint System

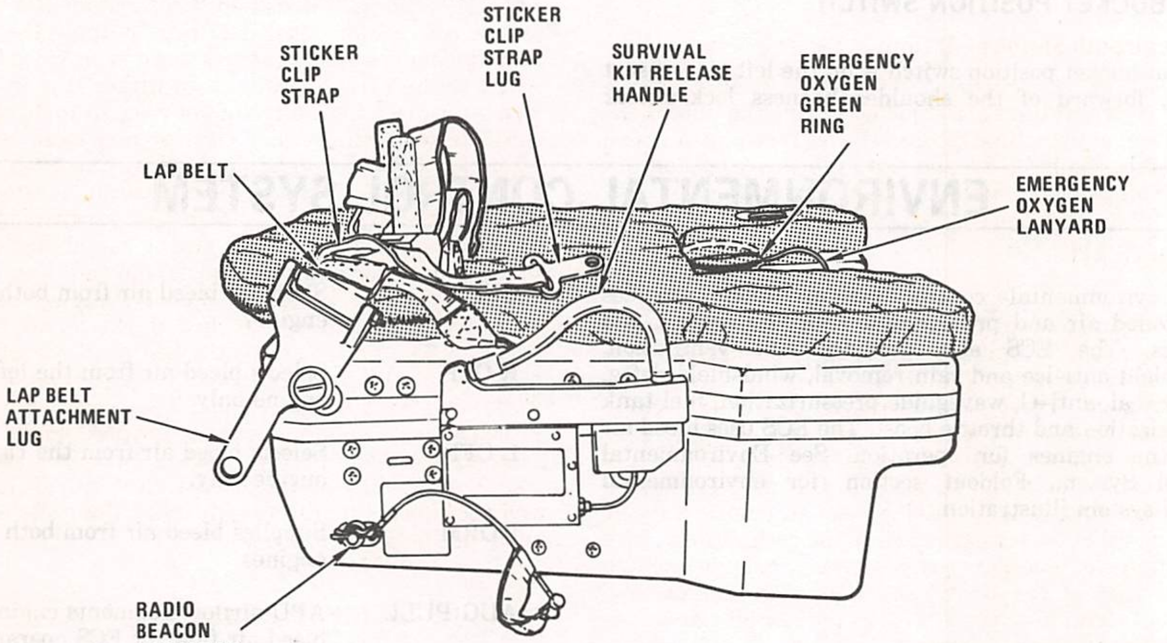
MANUAL OVERRIDE HANDLE

A manual override handle permits releasing the pilot's lower harness restraints and the leg restraint lines for emergency egress, and permits resuming part of the ejection sequence (man-seat separation and main parachute deployment) in the event of sequencing failure during ejection. The manual override handle, on the right side of seat bucket and just aft of the ejection seat safe/arm handle, is actuated by first pressing a thumb button on the forward part of the handle and then rotating the handle up and aft. If the handle is actuated on the ground or in the air before ejection, the following restraints are released: survival kit attachment lugs and the leg restraint lines. During ground emergency egress, after the manual override handle is pulled and the parachute riser fittings are released, the pilot is free to evacuate the aircraft with his survival kit still attached. If the manual override handle is actuated after ejection before man-seat separation occurs, the following events take place: release of same restraints as described in the emergency ground egress, firing of the manual override initiator cartridge which fires both the time release mechanism and drogue gun secondary cartridge (if they haven't been fired), inertia reel shoulder harness straps are released from seat, flaps of main parachute pack are unlocked, and the scissor shackle on the top of the seat is released to allow the drogue chutes to deploy the main parachute. The ejection seat safe/armed handle automatically rotates to the SAFE position whenever the manual override handle is actuated.

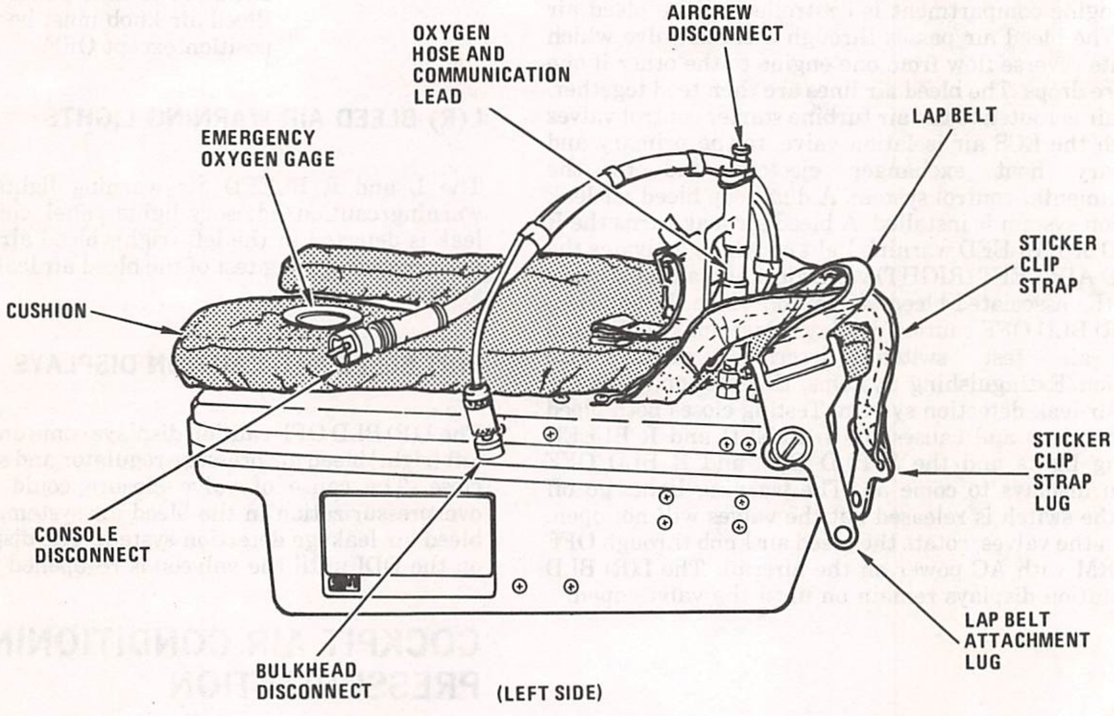
WARNING

Do not pull the manual override handle in flight. Actuation disconnects the survival kit attachment lugs and the leg restraint lines. Since

Survival Kit



(RIGHTSIDE)



(LEFT SIDE)

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Figure 1–23. Survival Kit

only the leg restraint lines can be re–connected during flight, this would make ejection extremely hazardous.

SEAT BUCKET POSITION SWITCH

The seat bucket position switch is on the left side of seat bucket, forward of the shoulder harness lock/unlock handle. The forward switch position lowers the seat bucket, the aft position raises the seat bucket, and the center off position, to which the switch is spring–loaded, stops the seat bucket. The maximum vertical travel of the seat bucket is 5 inches. The actuator should not be operated over 1 minute during any 8 minute period.

ENVIRONMENTAL CONTROL SYSTEM

The environmental control system (ECS) provides conditioned air and pressurization for the cockpit and avionics. The ECS also provides suit ventilation, windshield anti–ice and rain removal, windshield defog, canopy seal, anti–G, waveguide pressurization, fuel tank pressurization and throttle boost. The ECS uses bleed air from the engines for operation. See Environmental Control System, Foldout section, for environmental control system illustration.

BLEED AIR SYSTEM

Bleed air comes from the compressor section of each engine. A bleed air pressure regulator and shutoff valve in each engine compartment is controlled by the bleed air knob. The bleed air passes through a check valve which prevents reverse flow from one engine to the other if one pressure drops. The bleed air lines are then teed together. Bleed air is routed to the air turbine starter control valves through the ECS air isolation valve, to the primary and secondary heat exchanger ejectors and to the environmental control system. A dual loop bleed air leak detection system is installed. A bleed air leak turns the R BLEED or L BLEED warning light on which activates the BLEED AIR LEFT (RIGHT) voice alert and automatically closes the associated bleed air shutoff valve. In addition, the L(R) BLD OFF caution display comes on. The fire and bleed air test switch, described under Fire Detection/Extinguishing Systems, this section, tests the bleed air leak detection system. Testing closes both bleed shutoff valves and causes the L BLEED and R BLEED warning lights and the L BLD OFF and R BLD OFF caution displays to come on. The warning lights go off when the switch is released but the valves will not open. To open the valves, rotate the bleed air knob through OFF to NORM with AC power on the aircraft. The L(R) BLD OFF caution displays remain on until the valves open.

BLEED AIR KNOB

The BLEED AIR knob, on the ECS panel on the right console, selects the engine bleed air source for the ECS system.

OFF	Shuts off bleed air from both engines.
R OFF	Selects bleed air from the left engine only.
L OFF	Selects bleed air from the right engine only.
NORM	Supplies bleed air from both engines.
AUG PULL	APU airflow augments engine bleed air flow for ECS operation. Position can only be used on the ground, is solenoid held, and reverts to off if electrical power is lost, or when both throttles are advanced to MIL power or greater. Bleed air knob must be in any position except OFF.

L(R) BLEED AIR WARNING LIGHTS

The L and R BLEED air warning lights, on the left warning/caution/advisory lights panel, come on when a leak is detected in the left (right) bleed air system. They also come on during test of the bleed air leakage detection system.

L(R) BLEED OFF CAUTION DISPLAYS

The L(R) BLD OFF caution displays come on whenever the left (right) bleed air pressure regulator and shutoff valve(s) close. The cause of valve closure could be a leak or overpressurization in the bleed air system, or test of the bleed air leakage detection system. The display(s) remain on the DDI until the valve(s) is re–opened (reset).

COCKPIT AIR CONDITIONING AND PRESSURIZATION

Cockpit air conditioning and pressurization controls are on the ECS panel. The cockpit pressure altitude is shown on the cockpit altimeter on the lower center instrument panel. Cockpit altitude is approximately the same as aircraft altitude below 8000 feet. Cockpit altitude remains at 8000 feet between 8000 and 23,000 feet aircraft altitude. Above approximately 23,000 feet, cockpit altitude increases slowly to approximately 14,500 feet at 35,000 feet airplane altitude and 20,000 feet at 50,000 feet airplane altitude.A rule of thumb for cockpit altitude above 23,000 feet airplane altitude is:

Airplane altitude × 0.4 = cockpit altitude.

MODE SWITCH

AUTO	Cockpit and suit vent temperature maintained as selected by temperature knobs.
MAN	Cockpit and suit vent temperature directly controlled by temperature knobs. Position applies maximum airflow to cockpit and avionics.
OFF/RAM	ECS shut off. Cockpit ram air valve and liquid cooling air scoop opened.

TEMPERATURE KNOBS

The outer knob controls cockpit temperature as programmed by the mode switch. The inner knob controls suit vent air temperature as programmed by the mode switch.

CABIN PRESSURE SWITCH

NORM	Cockpit pressurized by ECS
DUMP	Cockpit unpressurized
RAM/DUMP	Cockpit ram air valve opens, ECS compressor/turbine output air to cockpit is shut off, and cabin pressure dump valve opens. Warm air is available through the cabin add heat valve to mix with the ram air.

DEFOGGING SYSTEM

The defogging system receives a portion of the conditioned air that is delivered to the cockpit and controlled by the mode switch and outer temperature knob as described above. The air is directed to a defog nozzle inboard of the forward portion of the windshield. The amount of defog air is controlled by the defog handle.

DEFOG HANDLE

The defog handle, on the right console outboard of the ECS panel, controls the division of air flow between the windshield defog outlets and the cockpit air outlets. As the handle is moved toward HIGH (forward), more air is diverted to the defog outlets. With defog handle set within ten percent of HIGH, the air temperature increases.

WINDSHIELD ANTI–ICE AND RAIN REMOVAL SYSTEM

The windshield anti–ice and rain removal system supplies controlled temperature air to the anti–ice/rain removal nozzle to provide airflow over the external surface of the windshield. The area affected is approximately 20 inches to the left and 9 inches to the right of windshield centerline, and at eye level (design eye) and below.

WINDSHIELD ANTI–ICE/RAIN SWITCH

The windshield anti–ice/rain switch is on the right console aft of the defog handle.

OFF	No anti–ice/rain removal air flow. This center position is lever–locked and the switch must be pulled up before placing it to either of the other two positions.
ANTI ICE	High–volume high–pressure air at 250°F is distributed across the windshield.
RAIN	Low–volume low–pressure air at 250°F is distributed across the windshield.

WINDSHIELD HOT DISPLAY

If the temperature of the air being distributed across the windshield becomes excessive or the windshield temperature sensor fails a WDSHLD HOT caution is displayed on the DDI.

SUIT VENTILATION SYSTEM

The suit ventilation system supplies temperature controlled and pressure regulated air to the pilot's vent suit disconnect located on the left console. Selected vent suit temperature is controlled by the air conditioning system controller operating the vent suit temperature sensor and vent suit temperature valve. The system is operational with the ECS MODE switch on the ECS panel, located on the right console, in MAN or AUTO. (See MODE SWITCH for operational control of the system). Flow rate to the vent suit can be reduced below maximum by the use of the vent suit flow control knob on the pilot services panel located on the left console.

ANTI–G SYSTEM

The anti–g system allows air pressure into the suit proportional to the G force experienced. A button in the valve allows the pilot to manually inflate his suit. The system incorporates a pressure relief valve.

AVIONICS COOLING AND PRESSURIZATION

Avionics cooling and pressurization is augmented by ram air if the flow drops below the desired value. If avionics cooling is inadequate, the AV AIR HOT caution display will come on. If the temperature in either flight control computer A or the right transformer-rectifier is high, FCS HOT caution display and light will come on. Placing the FCS COOL switch, on the lower right instrument panel, to EMERG will open a ram air scoop to supply cooling air to these units. The scoop cannot be closed in flight.

FAN TEST SWITCH

The fan test switch located above the aft end of the right console permits maintenance testing of the cockpit avionics cooling fans.

EMERGENCY EQUIPMENT

JETTISON SYSTEMS

The jettison systems consist of the emergency jettison system and the selective jettison system.

EMERGENCY JETTISON BUTTON

The emergency jettison system utilizes the emergency jettison button to jettison all stores/launchers/racks from the BRU-32A racks on the five pylon weapon stations (2, 3, 5, 7, and 8). The landing gear handle must be up or the weight must be off the aircraft to enable the emergency jettison button. The emergency jettison button, labeled EMERG JETT, is on the left edge of the instrument panel and is painted with alternating black and yellow stripes.

SELECTIVE JETTISON

Selective jettison is performed by the selective jettison knob in conjunction with the station jettison select buttons. The station jettison select buttons are used to select which weapon station or stations will be jettisoned. The selective jettison knob is used to select jettison of either the stores or the stores and launchers/racks on the weapon stations selected by the station jettison select buttons. After station and store/launcher/rack selection, jettison is performed by pressing the JETT center pushbutton in the selective jettison knob. In addition, the selective jettison knob can jettison the right or left fuselage Sparrow missile by selecting R FUS MSL or L FUS MSL and pressing the JETT center pushbutton. Selective jettison can only be performed with the landing gear up and locked with the master arm switch in ARM, and jettisons the stores in a safe condition.

Station Jettison Select Buttons

The station jettison select buttons are on the left edge of the instrument panel below the emergency jettison button. The buttons are labeled CTR (center), LI (left inboard), RI (right inboard), LO (left outboard) and RO (right outboard). Pressing a button illuminates an internal light and selects a weapon station for jettison. The station jettison select buttons are also used in the backup A/G weapon delivery modes for weapon selection; refer to part 10 in the Supplemental Flight Manual, A1-F18AC-NFM-100.

Selective Jettison Knob

The selective jettison knob on the left vertical panel has rotary positions L FUS MSL, SAFE, R FUS MSL, RACK/LCHR, and STORES. L FUS MSL and R FUS MSL selects the required fuselage Sparrow for jettison. The RACK/LCHR and STORES positions select what is to be jettisoned from the weapon stations selected by the station jettison select buttons. The JETT center pushbutton activates the jettison circuits provided the landing gear is up and locked and the master arm switch is in ARM. The SAFE position prevents any selective jettison.

Auxiliary Release Switch

The auxiliary release switch, on the lower instrument panel, is used to enable jettison of hung stores from BRU-32/A racks on stations 2, 3, 5, 7, and 8. A need to use the auxiliary release switch is indicated by a hung indication on the DDI after selective jettison or a normal weapons release is attempted. Place the switch to ENABLE to select the auxiliary release function. The master arm switch must be in ARM. Initiate jettison by selecting RACK/LCHR or STORES on the selective jettison knob, select the hung store station by pressing the appropriate station jettison select button, and then press the JETT center pushbutton of the selective jettison knob. The SMS provides a jettison signal to fire the auxiliary cartridge in the BRU-32/A rack on which the hung store is loaded. After the cartridge is fired, the store is gravity dropped in a safe condition.

WARNING/CAUTION/ADVISORY LIGHTS AND DISPLAYS

The warning/caution/advisory lights and displays system provides visual indications of normal aircraft operation and system malfunctions affecting safe operation of the aircraft. The lights are on various system instruments and control panels in the cockpit. The red warning lights indicate system malfunctions requiring immediate action. Caution lights and displays indicate malfunctions requiring attention but not immediate action. After the malfunction has been corrected, warning and caution

STATUS MONITORING SUBSYSTEM

The status monitoring subsystem, figure 1-24, provides the pilot with simple displays of system status, Most information is derived from built-in-test (BIT) mechanizations within the avionic sets and from non-avionic built-in-tests (NABIT) implemented in the computer software for other aircraft subsystems.

The subsystem monitors engines and airframe operational status for unit failures and caution/advisory conditions when the mission computer system is operating. When the mission computer system detects a caution/advisory condition, it commands display of the applicable caution or advisory message on one of the cockpit DDIs. If the mission computer system detects a unit failure, it commands the subsystem to store the applicable maintenance code in the DDI in the nose wheelwell. The mission computer (MC) displays the subsystem BIT results on one of the cockpit DDIs.

Non-BIT equipment status include DDI configuration display ID numbers and INS terminal data.

AVIONIC BIT

In most instances, two types of BIT are mechanized, periodic and initiated. Periodic BIT begins functioning upon equipment power application. It provides a failure detection capability that is somewhat less than that provided by initiated BIT in that it does not interfere with normal equipment operation.

Two forms of BIT derived data are supplied to the MC. One form is validity information associated with selected data. The second form is the equipment failure information which identifies failed assemblies. The MC uses these two forms of BIT data to implement reversion operation and advisories for the pilot as well as equipment status displays for both the pilot and maintenance personnel.

REVERSION

When the BIT equipment determines that a function has exceeded a predetermined threshold, the data derived from that function is immediately indicated as not valid. The MC, upon receiving this indication, reverts to the next best available source which in many cases is as accurate as the original source. This reversion is maintained as long as the data remains invalid from the primary source.

Figure 1-25 illustrates this concept for the flight aids. For each unit in the primary path, there is at least one alternate source of data for reversion. The pilot is provided appropriate display cuing only when a reversion results in some loss of capability or performance. For example, if angle of attack is lost from the ADC, the MC reverts to FCES derived angle of attack. No display change or pilot cuing is made since the accuracy of the alternate source is equivalent to the primary source. If, however, the altitude switch is in RDR and the radar altimeter fails, the MC removes the displayed radar altitude, replaces it with barometric altitude, and indicates the barometric altitude display via cuing. If altitude is lost from the ADC and the altitude switch is in the BARO, the MC removes the displayed altitude from the HUD. These examples illustrate three forms of degraded mode advisories: (1) reversion to an alternate data source of equivalent accuracy with no pilot cuing; (2) reversion to an alternate data source of lesser accuracy with pilot cuing; (3) and removal of displayed data when no acceptable alternate source is available. Refer to section VIII for further discussion on weapon system reversions.

EQUIPMENT STATUS DISPLAYS

Equipment status displays (BIT, caution, and advisory) provide the pilot with continuous status of the avionics equipment and weapons. A cue to check equipment BIT status is the appearance of the BIT advisory display on either DDI or the HI. The display is normally on the left DDI. A MENU selectable BIT control display contains the current status of all avionics equipment which interface with the MC. See figure 1-26. Messages displayed as a function of equipment status are listed in the following table.

STATUS MESSAGE	APPLICABLE SYSTEM	MESSAGE DEFINITION
NOT RDY	All systems except MC1	Equipment OFF, not installed, or initializing.
IN TEST	All systems except MC1, MC2	Initiated BIT in progress.
SF TEST	RDR, TCN, SMS (161702 and up)	Self test in progress (cannot be operator terminated).

CONTINUED

GO	All systems	Initiated BIT completed without failure.
DEGD	All systems except MC1, MC2	Failure detected; equipment operation degraded.
NO GO	HARM, LST, FLIR, SMS, RDR, LDDI, RDDI, CAM, CSC, SDRS, MC1, MC2, FCSA, FCSB, INS, ADC COM1, COM2, D/L	Equipment ON but not communicating.
OH	FLIR, SMS, RDR, CSC, FCSA, FCSB, INS, LST, CAM	Overheat.
DEGD OH	FLIR, SMS, RDR, CSC, FCSA, FCSB, INS, LST, CAM	Detected failure and overheat.
RESTRT	All systems except MC1, MC2	Reinitialize BIT; equipment did not respond to BIT command.

No indication (blank) adjacent to the equipment legend indicates that initiated BIT has not been run on the equipment and that the periodic BIT has not detected any faults. LDDI, RDDI and HSD have unique degraded messages of DEGD 1, DEGD 2 and DEGD 1/2 in the TF/A–18A to allow distinguishing BIT status failures of front seat displays (1) from rear seat displays (2).

Weapon and stores status is primarily displayed on the STORES display (selected from the MENU display). When the BIT display indicates a stores management system (SMS) failure, the affected stations and degree of failure will be identified on the STORES display as described in section VIII in NATOPS Supplement, A1-F18AC-NFM-100.

When the left DDI is used for any display option other than the BIT displays, cautions and advisory displays are displayed along with the selected option (figure 1–27). Caution displays appear as 150%–size letters compared to the normal message symbology size. The caution displays are displayed as they occur beginning in the lower left portion of the DDI display and sequence to the right up to three displays across. Upon occurrence of the fourth caution, it re–indexes to the left edge above the first caution which appeared. This process can continue for up to 14 lines with three caution displays in each line, should that many caution conditions occur. Advisory displays appear as 120%–size letters on a single line beneath the caution displays. The advisories are preceded by an ADV–5 legend and the individual advisories are separated by commas.

Normally cautions and advisory displays are displayed on the left DDI. If the left DDI or the right DDI fails or is turned off, the HI displays the cautions and advisories. If the left DDI and HI fail or are turned off, the right DDI displays the cautions and advisories. When a caution occurs, the MASTER CAUTION light on the main instrument panel illuminates and the MASTER CAUTION tone or a voice alert is heard in the headset. The MASTER CAUTION light is extinguished by pressing the light. Refer to Warning/Caution/Advisory Displays in section V for the display implications and corrective action procedures.

BIT INITIATION

In addition to displaying equipment BIT status, the BIT control display (figure 1–26) is used to command initiated BIT. Those avionic sets identified by the legends on the display periphery have an initiated BIT capability. The pilot commands initiated BIT by pressing the adjacent button. The status messages are displayed as required as each equipment set enters, performs, and completes its BIT routine. BIT may be initiated one at a time or in any combination. In the case of the INS and FCS additional switchology is required. Selection of AUTO BIT (figure 1–28) causes a simultaneous BIT of all equipment except those tested by the DSPL/EPI/UFC button. Performance of BIT assumes the required electrical and hydraulic power is applied to the equipment tested. The following includes certain initiated BIT which require steps in addition to pressing one of the buttons on the BIT display and reading the BIT status messages after the test is complete. Figure 1–27 shows which initiated BITs are not allowed inflight.

Status Monitoring Subsystem

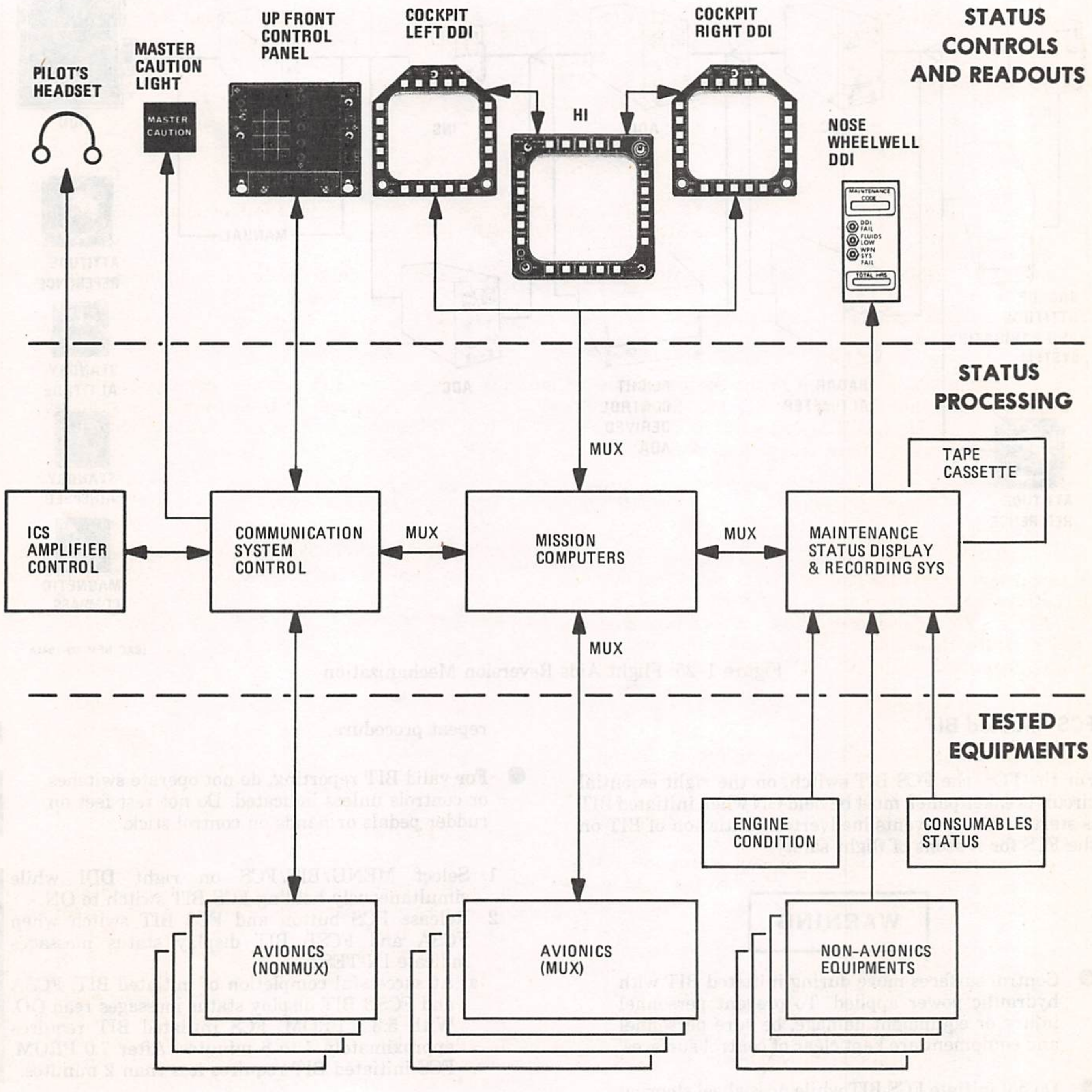

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Figure 1–24. Status Monitoring Subsystem

Flight Aids Reversion Mechanization

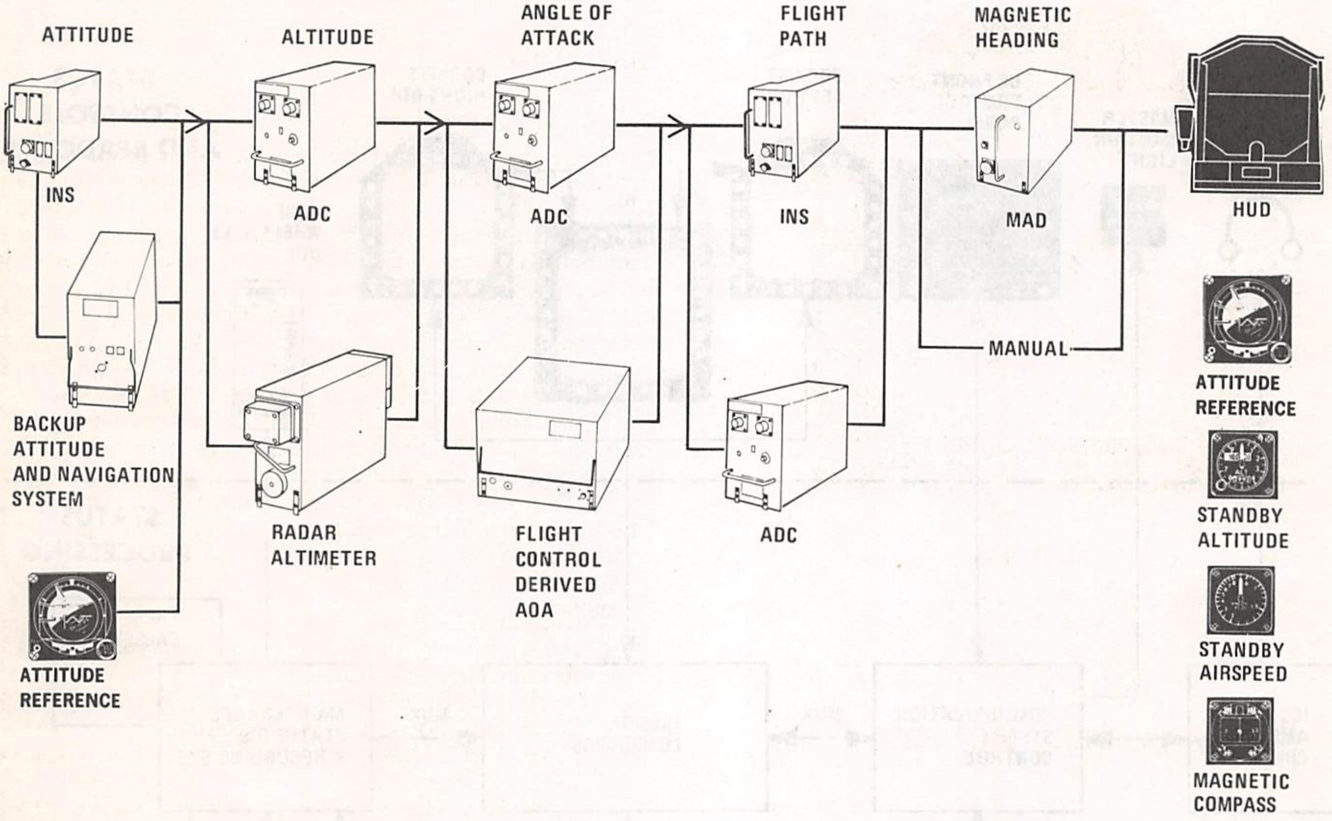


Figure 1–25. Flight Aids Reversion Mechanization

FCS Initiated BIT

For the FCS, the FCS BIT switch, on the right essential circuit breaker panel, must be held ON when initiated BIT is started. This prevents inadvertent initiation of BIT on the FCS for reasons of flight safety.

WARNING

- Control surfaces move during initiated BIT with hydraulic power applied. To prevent personnel injury or equipment damage, be sure personnel and equipment are kept clear of control surfaces.
- Do not initiate FCS BIT while nosewheel steering is engaged, as nosewheel steering will be lost. After 8.2 PROM, initiated FCS BIT cannot be performed with nosewheel steering engaged.

NOTE

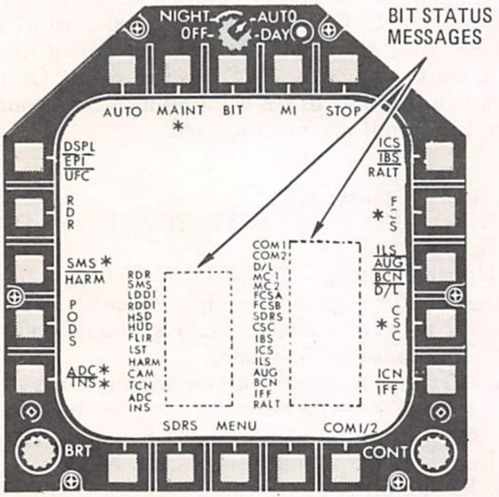
- For initiated BIT to start, FCS BIT switch must be held for at least 2 seconds. If not held for the required time, RESTRT is displayed as the BIT display status message. If RESTRT displayed, repeat procedure.
- For valid BIT reporting, do not operate switches or controls unless indicated. Do not rest feet on rudder pedals or hands on control stick.

1. Select MENU/BIT/FCS on right DDI while simultaneously holding FCS BIT switch to ON.
2. Release FCS button and FCS BIT switch when FCSA and FCSB BIT display status messages indicate IN TEST.
   a. At successful completion of initiated BIT, FCSA and FCSB BIT display status messages read GO. With 5.3.1 PROM, FCS initiated BIT requires approximately 7 to 8 minutes. After 7.0 PROM, FCS initiated BIT requires less than 2 minutes.

SMS Initiated BIT

Safeguards have been built into the weapon system mechanization to allow SMS initiated BIT to be performed with weapons loaded and cartridges installed. During initiated BIT, weapon release signals and associated circuitry are not exercised unless all of the following interlocks are satisfied simultaneously: master arm switch

BIT Control Display



NOTE

* Initiated BIT is not allowed inflight (legends are only displayed on the ground).

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Figure 1–26. BIT Control Display

Caution/Advisory Indications

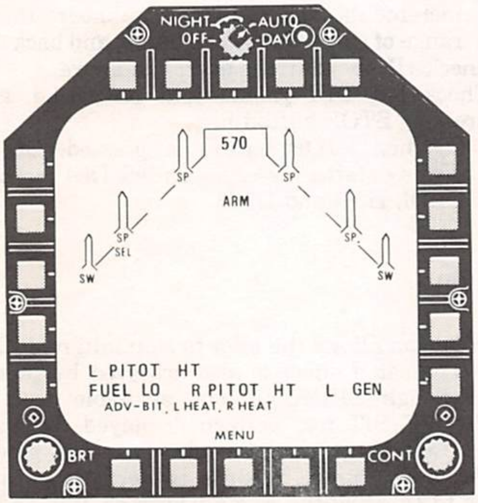

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Figure 1–27. Sample Caution/Advisory Indications

to ARM, armament safety override in override, weapon load codes on stores processor set to zero, and no weapon ID detected on any weapon station. SMS initiated BIT should not be attempted until the above interlocks are in a safe condition. The SMS initiated BIT should be successfully completed within 180 seconds of initiation.

INS Initiated BIT

To perform initiated BIT, the INS must be in the TEST mode and a ground/carrier selection must be made to indicate where the BIT is being accomplished. When the ADC/INS (or AUTO) button is actuated, a display message of GND/CV? appears next to the INS legend in the status display area (figure 1–28). At the same time, new button labels appear along the bottom of the display. These options allow entry of where the initiated BIT will be performed, i.e., on the ground or on a carrier. A third option, INS LNG (INS long test), identifies if the platform slew portion of the INS test is desired. The platform slew test, which adds an additional 26 minutes to the normal 12 minutes INS BIT time, is only performed when the INS exhibits degraded navigation performance during a flight and normal BIT routines do not detect any malfunction. This option should be selected prior to selecting the ground or carrier option.

1. Check parking brake set.
2. For ground initiated BIT insure waypoint zero is local latitude/longitude.
3. Select MENU/BIT/ADC/INS (or AUTO) on right DDI and TEST on INS mode switch.
4. Select INS LONG (if required) and GND or CV on DDI, and start clock.
   a. At successful completion of test BIT display status message reads GO. Maximum time for INS initiated BIT is 12 minutes and maximum time for INS initiated BIT and platform slew test is 45 minutes.

AUTO BIT

If the AUTO button is pressed, BIT are initiated in parallel for all equipment turned ON and whose interlocks are satisfied. The test pattern associated with the DDI and HUD is not displayed when the AUTO option is used. Approximately 2 1/2 minutes are required for all AUTO BIT except FCS and INS.

> On airplanes 161353 thru 161528, an anomaly exists which causes a COM 1 failure indication any time an AUTO BIT is run. No maintenance code is set in the nose wheel well DDI. Judgement should be excercised in determining when there is an actual failure, with consideration given to irregularities such as communication difficulties during flight.

1. Check power applied to all systems requiring BIT and check required interlocks in safe condition.
2. Select MENU/BIT/AUTO on DDI.
   a. All systems read GO (see figure 1–28) after required test period. Go indication is provided when system check is complete and OK. Other

ADC/INS BIT-AUTO BIT Display

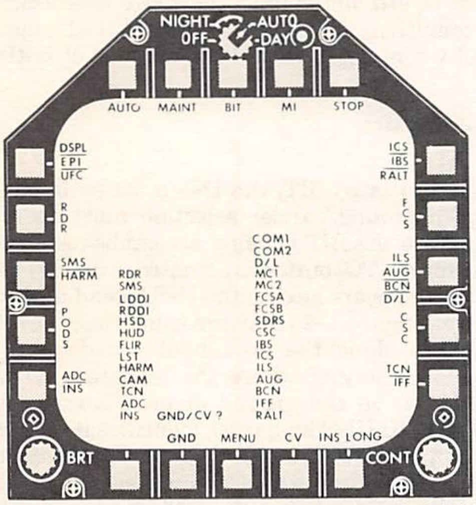

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Figure 1–28. ADC/INS BIT – AUTO BIT Display

messages may be displayed if malfunctions are detected.

3. If FCS test required, perform FCS Initiated BIT above while substituting the AUTO button for the FCS button in the procedure.

   Insure the procedural warnings and notes are observed and that the AUTO button and FCS BIT switch are held simultaneously to initiate test.

4. If INS test required, perform INS initiated BIT above while substituting the AUTO button for the ADC/INS button in the INS Initiated BIT procedure.

DSPL/EPI/UFC Initiated BIT

Operator participation in the detection of failures and the isolation of faults is required for the display equipment. The DSPL/EPI/UFC button calls up the MC generated test pattern on the DDI, HI and HUD immediately after the BIT routine mechanized within each indicator is concluded. The test pattern can then be compared on the four displays for similarity, and individually for concentricity, intensity level, and alphanumeric clarity. Pushbutton tests are accomplished by actuating the button. A circle appears adjacent to the button when the functional test is successfully completed. In addition to displaying the DDI, HI and HUD BIT test patterns, pressing the DSPL/EPI/UFC button initiates engine monitor indicator (EPI) and upfront control BIT checks. See figure 1–29.

Pressing the DSPL/EPI/UFC initiates BIT on three different equipment display groups. The following procedure can be used to test all groups simultaneously, or to test one or two of the display groups by performing the appropriate parts of the procedure. Regardless of whether the whole or a part of the procedure is required, the total time allowed for the test should be a minimum of 25 seconds. The EPI BIT display must be allowed to complete the described cycle before the BIT stop button is pressed. The reason for this is that when the DSPL/EPI/UFC BIT is initiated and the STOP button is pressed before the EPI BIT runs through to completion, the second half of the UFC BIT will be altered during the next test. Should an alteration of the second half of the UFC BIT occur, the problem might be cleared by running another EPI BIT to completion. The UFC would then test good during the next BIT check. The HI must be turned of during the UFC check or disruption of the UFC BIT will result. On 161925 and up, running the BIT a minimum of 25 seconds and turning the HI off are not required.

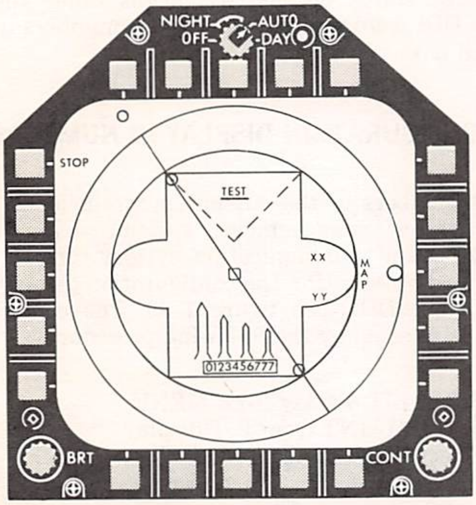
1. Turn HI power off.
2. Select MENU/BIT/DSPL/EPI/UFC on DDI (see figure 2–29)
3. Upfront control – CHECK
   a. All outer segments of alphanumeric displays, all segments of numeric displays, and all option cues illuminate for 5 seconds.
   b. All inner segments of alphanumeric displays, all segments of the numeric displays, and all option cues illuminate for the next 5 seconds.
4. Engine monitor indicator – CHECK
   a. RPM – 50%
   b. EGT – 555°C
   c. FF – 5200 PPH
   d. NOZ POS – 40%
   e. OIL – 150 PSI
5. Turn HI power on.
6. HUD, HI, and DDI displays – CHECK
   a. Display commonality
   b. Display concentricity
   c. Proper intensity
   d. Check right DDI pushbuttons (20) starting with top left button on horizontal row
      (1) Circle appears next to push button after it is pressed.
   e. Press MAP pushbutton on HI display.
      (1) Test circled displayed next to MAP pushbutton and moving map filmstrip number displayed.
   f. Press MAP pushbutton to increment selected map number to same value as filmstrip number
      Continual pressing of MAP pushbutton increments selected map number through range of three values, 01, 02, 03, and back to 01.
   g. Check HI pushbuttons as in 4.d. above
   h. Check left DDI pushbuttons as in 4.d. above pressing STOP button last.
      (1)When STOP button is pressed, GO BIT display status messages on left DDI for LDDI, RDDI, HSD and HUD.

Stop Button

The STOP button allows the pilot to stop initiated BIT at any time. The same effect is also achieved by pressing MENU, although MENU is not available with the DSPL/EPI/UFC BIT test pattern displayed. When the STOP (or MENU) button is pressed, any test in progress stops and the equipment returns to normal operation. Exceptions to this are the radar power–on BIT and the tacan BIT. The radar power–on BIT cannot be terminated and, as such, indicates SF TEST when the MC detects the system is in BIT without having been commanded to do so. The same is true of the tacan equipment which performs

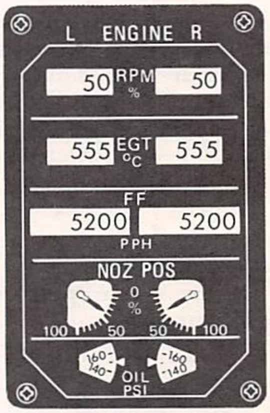
DSPL/EPI/UFC BIT Displays

HUD, HI, AND DDI BIT DISPLAY



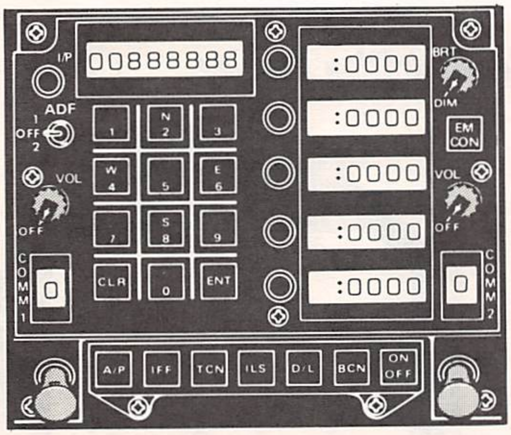
- A circle is displayed adjacent to the button only after individual button is actuated and it passed functional test.
- The diagonal line, 2 circles in the corners, film strip XX (map number), YY (select map number), and MAP button label only appear on the horizontal indicator.
- Stop button enables termination of CRT BIT.

ENGINE MONITOR INDICATOR BIT DISPLAY



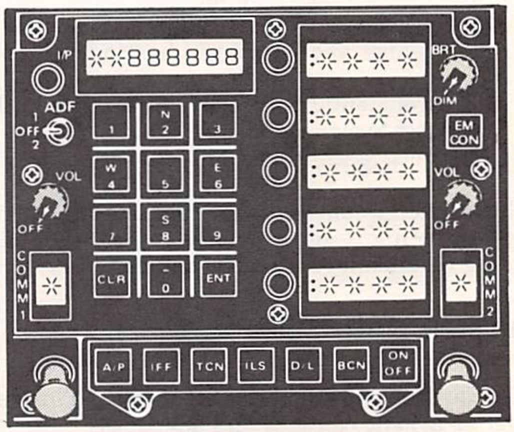
- Illustrated indications appear for 8 seconds.
- After 8 seconds, digits cycle from 0 to 9; most significant digit for RPM and FF only indicate 1 during this test.

UPFRONT CONTROL BIT DISPLAY



FIRST 5-SECOND PERIOD

All outer segments of alphanumeric displays, all segments of numeric displays, and all option cues illuminate.



SECOND 5-SECOND PERIOD

All inner segments of alphanumeric displays, all segments of numeric displays, and all option cues illuminate.

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Figure 1-29. DSPL/EPI/UFC BIT Displays

a canned non-interruptable BIT sequence. Prior to 161925, when DSPL/EPI/UFC initiated BIT is selected, the EPI display must be allowed to complete its display cycling before STOP is pressed or a UFC BIT failure will be indicated.

BLIN CODES

BIT logic inspection (BLIN) codes are octal readouts identifying FCS failures. The following precedures may be used to display and record BLIN codes. Data is displayed on the DDI under DATA. Data is displayed in four lines. The first line is channel 1 data. The second, third and fourth lines are channels 2, 3 and 4 data. Before 7.0 PROM the codes must be read before power is removed from the system.

1. On DDI – PRESS MENU/BIT/MI
2. UFC option – PRESS UNT
3. Keyboard – TYPE 14, PRESS ENT
4. UFC option – PRESS ADDR
5. Keyboard – TYPE 1377 with 5.3.1 PROM, 3007 after 7.0 PROM, PRESS ENT
6. DDI BLIN codes – RECORD BY CHANNEL

NON–AVIONIC BIT

NABIT is implemented within selected hydromechanical subsystems primarily for the purpose of displaying subsystem status in the cockpit (cautions and advisories) and/or providing fault detection and fault isolation information for maintenance personnel. This status data is provided to the status monitoring displays by the maintenance signal data recording set which interfaces with the following hydromechanical areas:

a. Engine/Secondary Power.
b. Electrical.
c. Hydraulics and Landing/Arresting Gear.
d. Fuel.
e. Environmental Control System and Radar Liquid Cooling System.
f. Controls/Mechanisms/Miscellaneous.

The hydraulic system pressure cautions are interfaced directly by both mission computers (support and tactical) providing redundancy for safety of flight.

EQUIPMENT STATUS DISPLAYS

NABIT cautions and advisories are displayed in the same manner as avionic cautions and advisories.

STATUS MONITORING BACKUP

MC2 provides backup status monitoring if MC 1 fails. It provides an MC 1 caution on the DDI indicating that MC 1 has failed. It also provides HYD cautions.

NOTE

If MC 1 fails, all DDI cautions and advisories will be lost except MC 1, HYD 1A, HYD 1B, HYD 2A and HYD 2B. Menu options lost are BIT, CHKLST, ENG, ACL, and ADI.

NON–BIT STATUS

Equipment status derived by means other than BIT include DDI configuration display ID numbers and INS terminal data.

DDI CONFIGURATION DISPLAY ID NUMBERS

The ID numbers of the current program loads for the radar, stores management system, INS, mission computers, and communication system control can be determined by selecting the configuration display on the left or right DDI. See figure 1–30. The configuration display is selected by the following procedure:

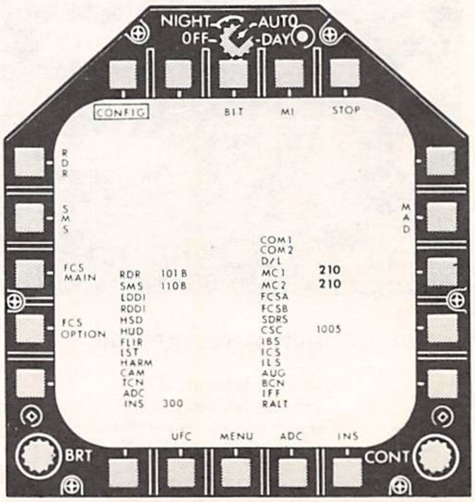
1. Select BIT display from MENU
2. Select MAINT from BIT display
3. Select CONFIG from MAINT

With the configuration display selected, the current ID numbers are displayed to the right of the above equipments, and the word CONFIG is boxed below the CONFIG button. The following table lists current ID numbers for applicable equipment.

Configuration Display ID Numbers

System	ID Number	Effectivity
RDR	101B	161353 thru 161924
RDR	102 1	161925 and up

Configuration Display



RDR 101B
SMS 110B
LDDI
RDDI
HSD
HUD
FLIR
LST
HARM
CAM
TCN
ADC
INS 300

COM1
COM2
D/L
MC1 210
MC2 210
FCSA
FCSB
SDRS
CSC 1005
IBS
ICS
ILS
AUG
BCN
IFF
RALT

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Figure 1–30. Configuration Display

Configuration	Display ID	Numbers
SMS	110B	161353 thru 161924
SMS	120B	161925 and up
INS	200	161520 thru 161528
INS	300	161529 and up
MC1	210	161353 thru 161924
MC1	300–XXX	161925 and up
MC2	210	161353 thru 161924
MC2	300–YYY	161925 and up
CSC	1003	161353 thru 161528
CSC	1005	161529 and up

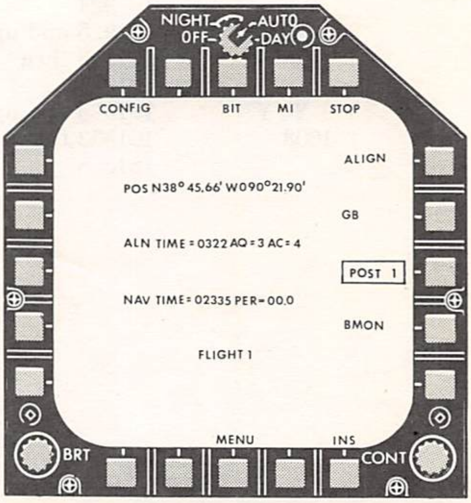
INS TERMINAL DATA

INS terminal data can be obtained if at least one update has been performed. On the DDI display, press the following pushbuttons in sequence: MENU, BIT, MAINT, INS, and POST. Note the PER (performance error rate) and navigation time on the FLIGHT 1, POST 1 display. See figure 1–31. Press the POST pushbutton again and note the velocity on the FLIGHT 1, POST 2 display. Turn the INS mode selector knob to OFF, then wait at least 10 seconds before turning off aircraft power.

INS Post Flight Data Displays

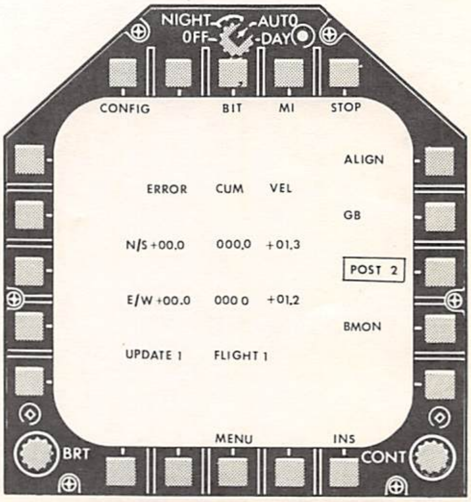
LAT = INS POSITION
LONG = INS POSITION
ALIGN TIME = TIME IN SECONDS
QUALITY = ALIGN QUALITY
AC = STATE COUNTER FOR ALIGN MODE
NAV TIME = TIME IN SECONDS
PER = INS PERFORMANCE (EQUALS RADIAL POSITION ERROR IN NAUTICAL MILES/HR)

TO CHECK INS PERFORMANCE, DO AN UPDATE, OVFLY, TO WAYPOINT 0.


NIGHT
AUTO
OFF
DAY
CONFIG
BIT
MI
STOP
ALIGN
POS N38° 45.66' W090°21.90'
GB
ALN TIME = 0322 AQ = 3 AC = 4
POST 1
NAV TIME = 02335 PER = 00.0
BMON
FLIGHT 1
MENU
INS
BRT
CONT

FLIGHT 1 THRU 5 (FLIGHT 1 SHOWN) - POST 1 DISPLAY

ERROR = IN N/S OR S/W THE UPDATES ARE ADDED ALGEBRAICALLY
CUM = ABSOLUTE VALUE OF UPDATES
VEL = VELOCITY IN N/S OR E/W DIRECTION
UPDATES = NUMBER OF UPDATES



FLIGHT 1 THRU 5 (FLIGHT 1 SHOWN) - POST 2 DISPLAY

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Figure 1-31. INS Post Flight Data Displays

FIGHTER/ATTACK TRAINER (TF/A-18A)

The airplane is a tandem configured airplane (see figure 1-32) which performs the secondary role of a trainer without compromising its primary role. To make room for the rear cockpit, the fuel quantity in tank 1 has been reduced to 316 gallons (2150 pounds JP-5 or 2050 pounds JP-4). The rear cockpit, and the differences relative to the single-seat version are discussed in following the paragraphs.

Using the front cockpit controls, the TF/A-18A avionics provide equivalent navigation and weapon system capabilities as those available in the single-place F/A-18A. The rear cockpit controls duplicate most front cockpit controls for navigation and weapon system control. However, weapons cannot be launched/released/fired from the rear cockpit.

AIRPLANE DIMENSIONS

The approximate dimensions of the airplane are as follows:

Span (Wings Spread) with missiles	40 feet 5 inches
without missiles	37 feet 6 inches
Span (Wings Folded)	27 feet 6 inches
Length	56 feet
Height (To Top of Fins)	15 feet 1 inch
Height (To Top of Closed Canopy)	11 feet 3 inches

AIRPLANE GROSS WEIGHT

The following gross weights are approximate to the nearest 100 pounds and shall not be used for computing airplane performance or for any type operation.

Empty weight	23,500 pounds
Operating weight (empty weight plus pilot, survival equipment, nose gun, oil and unusable fuel)	25,000 pounds
Takeoff gross weight (operating weight plus full internal fuel, ammunition, (2) AIM-7 and (2) AIM-9 missiles)	36,800 pounds
Takeoff gross weight plus 3 full external fuel tanks	44,800 pounds

CANOPY SYSTEM

The canopy system is similar to the F airplane except that an additional internal canopy jettison handle is installed in the aft cockpit. Note that the aft cockpit does not have an internal canopy switch or an internal manual canopy handcrank, and therefore, the canopy must be opened from the forward cockpit (or externally) unless it is jettisoned. To manually open the canopy using the internal manual handcrank, 224 counterclockwise manual crank turns are required. To manually open the canopy externally using a drive socket, 112 counterclockwise manual crank turns are required.

INTERCOM SYSTEM

Intercommunication between the pilot, ground crew, and the rear cockpit is provided by the intercom system. The system also provides amplification and routing of both internally and externally produced tones to the headsets. The comm control panel, which is an external panel,

General Arrangement (TF/A-18A)

TYPICAL

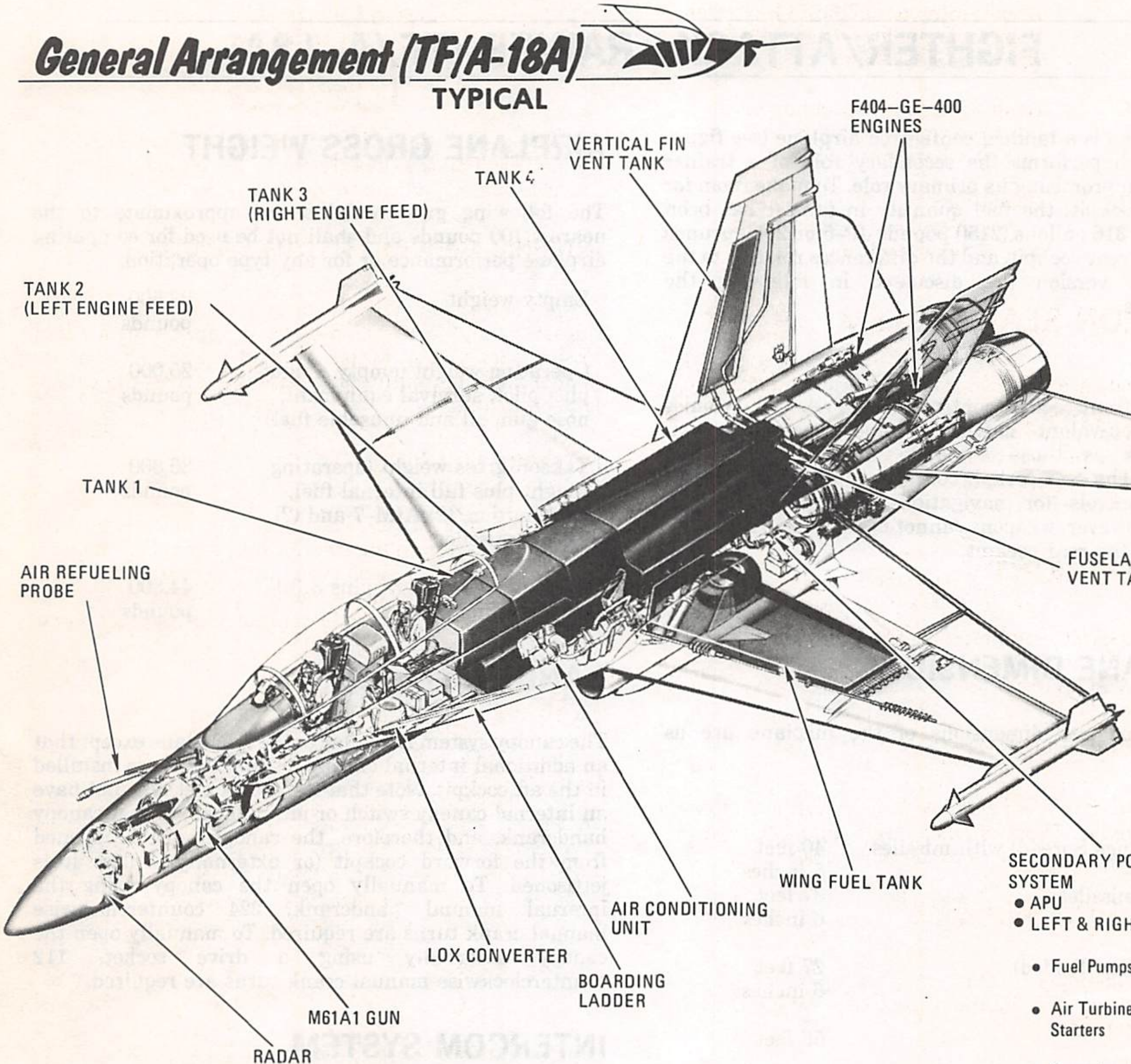

Figure 1-32. General Arrangement (TF/A-18A)

provides a ground cord receptacle and a volume control for the ground crew. The volume control adjusts the volume to the ground crew headset.

INTERCOM CONTROLS

Intercom controls consist of two cockpit volume control knobs and an intercom function selector switch.

Volume Control Knobs

The volume control knob on the intercommunication panel in the front cockpit is labeled ICS. This knob varies the audio volume to the pilots headset. The volume control knob in the rear cockpit is on the volume control panel on the left console. This knob is labeled ICS and varies the audio volume to the rear cockpit headset.

Intercom Function Selector Switch

A three-position toggle switch, with positions marked RADIO ORIDE (override), HOT MIC, and COLD MIC is on the antenna selector panel in the front cockpit and on the volume control panel in the rear cockpit. The functions of the switch positions are as follows:

RADIO ORIDE	Allows intercom audio to be louder than radio audio in the cockpit where selected.
HOT MIC	Enables cockpit microphone for intercom transmission in the cockpit where selected.
COLD MIC	Disables cockpit microphone for intercom transmission in the cockpit where selected.

EJECTION SEAT SYSTEM

Ejection seats are installed in both cockpits. In addition, a sequencing system is installed to allow dual ejection initiated from either cockpit or single (aft) seat ejection initiated from the rear cockpit. A command selector valve is installed in the aft cockpit to control whether ejection from the aft cockpit is dual or single.

REAR COCKPIT

The rear cockpit contains the equipment differences as described in the following paragraphs. Refer to Rear Cockpit, Foldout section for rear cockpit arrangements.

FIRE WARNING LIGHTS

The left and right engine and APU fire warning lights are advisory only. They do not arm or discharge the extinguishing system or shut down the engines or APU.

FUEL QUANTITY INDICATOR

The fuel quantity indicator has two counters. One indicates total fuel quantity and the other indicates internal fuel only.

COMMAND SELECTOR VALVE

A command selector valve is provided on the right vertical panel to select the desired ejection sequence to be initiated from the rear cockpit, or provide for single ejection for solo flight. Positioning is accomplished by pulling out while turning to the desired position. Solo position requires use of a collar. To release from aft initiate, pull then turn clockwise.

NORM (vertical)	Single rear seat ejection when initiated from the rear cockpit. Dual ejection (rear seat first) when initiated from the front cockpit.
AFT INITIATE (horizontal)	Dual ejection (rear seat first) when initiated from either seat.
SOLO 45° CCW	Single ejection from front cockpit only. Ejection from the front seat is immediate. Ejection from the rear seat is impossible.

CAUTION

When selecting NORM or SOLO from AFT INITIATE, the handle must be pulled before rotation or damage to valve may result.

INTERNAL CANOPY JETTISON HANDLE

A black and yellow striped canopy jettison handle is under the left canopy sill just aft of the volume control panel. Pressing an unlock button on the forward edge of the handle and then pulling the handle up fires the canopy jettison system.

INTERIOR LIGHTING

Except for the utility floodlight, all controls for the interior lights are on the interior lights panel on the right console. There is no flood switch in the rear cockpit. The switch logic for dimming and brightening the warning/caution lights is the same as the front cockpit but without the flood switch.

Lights Test Switch

A lights test switch, labeled LT TEST is provided to test the warning/caution/ advisory lights and is independent of the front cockpit. The switch only operates with AC power on the airplane.

TEST	Serviceable warning/caution/advisory lights will come on.
OFF	The switch is spring loaded off.

Master Caution Light

A yellow MASTER CAUTION light, on the upper instrument panel comes on whenever the MASTER CAUTION light in the forward cockpit comes on. The aft MASTER CAUTION light goes out whenever the forward cockpit MASTER CAUTION is reset.

LANDING GEAR UNSFE LIGHT

The red UNSFE light only indicates landing gear in transit. The light does not indicate unsafe landing gear, planing link failure, nor provide wheels warning.

LANDING GEAR POSITION LIGHTS

There are three green landing gear position lights marked NOSE, LEFT, and RIGHT above the landing gear control handle. The lights come on when their respective gear is down and locked. The LEFT and RIGHT lights flash when their respective gear is down and locked but a related planing link is not locked.

EMERGENCY BRAKE HANDLE

The emergency brake handle, on the left vertical panel, only provides emergency brakes. It has no parking brake function. To actuate the emergency brake system, pull out on the handle until it locks in the detent.

EMERGENCY LANDING GEAR HANDLE

The emergency landing gear handle, on the left vertical panel, provides emergency landing gear extension from the rear cockpit. Emergency extension is accomplished by pulling out on the handle until it locks in the detent. There are no provisions for normal landing gear extension.

DIGITAL DISPLAY INDICATORS

The corresponding left and right DDI in each cockpit presents the same information. The center DDI displays the same information as the HI, except for the moving map display. Systems and presentations controlled by DDI/HI pushbuttons respond to the last action taken in either cockpit.

HEAD-UP DISPLAY

The rear cockpit does not contain a HUD, but HUD symbology can be selected for display from the MENU on either the left or right DDI. This also selects HUD symbology on the same DDI in the front cockpit.

DISPLAY SELECT CONTROL

Airplanes 161704 and up have a display select control. This control is a toggle switch with positions of HUD and NORM. Placing the switch to HUD causes the HUD display to appear on the left DDI and removes and/or prevents caution and advisory displays on the left DDI. With the switch set to NORM, the DDI operates normally by using the pushbuttons.

UPFRONT CONTROL

The upfront control in each cockpit presents the same information. The associated UFC systems respond to the last selection made in either cockpit.

ATTITUDE REFERENCE INDICATOR

The attitude reference indicator (ARI) in the rear cockpit does not display azimuth and elevation steering during ILS operations.

MASTER MODE BUTTONS

The associated systems controlled by the A/A and A/G master mode buttons respond to the last selection made in either cockpit.

CONTROL STICK

The control stick switches respond to the last crew member action taken from either cockpit. With 5.3.1 PROM, opposing inputs from front and rear cockpits may cancel each other. The trigger switch and the weapon release button are non-functional.

A/A Weapon Select Switch

The rear cockpit weapon select switch is active only in the A/A master mode. In the rear cockpit, the A/A master mode must be selected with A/A master mode button.

THROTTLES

The throttles provide engine control from IDLE through MAX. The throttles cannot be placed in OFF from the rear seat. Systems controlled by throttle switches respond to the last crewmember action taken from either cockpit. The APC engage/disengage switch is non-functional, the flare/chaff switch is not installed, and the speed brake switch is momentary action.

ALE-39 PROGRAMMER

The ALE-39 programer is installed on the rear cockpit left console. The programmer controls are normally preset by the ground crew. Refer to AN/ALE-39 Countermeasures Dispensing Set in section VIII for description of the programmer control functions.

VOLUME CONTROL PANEL

The volume controls (TCN, ICS, ECM, WPN, and RWR), on the volume control panel, provide the same functions for the rear cockpit headset as the corresponding volume controls on the front cockpit intercommunication panel provide for the front cockpit headset. The SAM volume control on airplanes 161354 through 161357 and 161360 or the AUX volume control on airplanes 161704 and up are not used at the present time.

AZIMUTH INDICATOR

The azimuth indicator may be installed on airplanes 161704 and up and presents the same information as the front cockpit azimuth indicator.

EMERGENCY JETTISON BUTTON

The emergency jettison button is at the top of the instrument panel outboard of the left FIRE light.

PART 3 - SERVICING

SERVICING DATA

Refer to A1-F18AC-NFM-600.

PART 4 - OPERATING LIMITATIONS

AIRCRAFT

ENGINE LIMITATIONS

RPM

Compressor (N_2)

a. The maximum steady-state rpm is 102%.
b. Ground idle is 61 to 70%.
c. Flight idle is 68 to 73%.
d. Maximum fluctuation at stabilized power is ±1%.
e. Maximum transient is 104%.

Fan (N_1)

a. The maximum steady-state rpm is 106%.
b. Maximum fluctuation at stabilized power is ±0.5%.
c. Maximum transient is 109%.

EGT

a. Maximum steady-state is 830°C.
b. Maximum transient during engine start is 815°C.
c. Maximum fluctuation at stabilized power is ±8°C and a frequency less than 12 cycles per minute.

NOZZLES

a. Maximum fluctuation is ±3%.

OIL PRESSURE

Ground

a. For ambient temperatures above −18°C (0°F), oil pressure must peak below 180 psi and start to decrease within 30 seconds after reaching idle rpm and continue to decrease to steady state limits.
b. For ambient temperatures below −18°C (0°F), maximum oil pressure 2 ½ minutes after start is 180 psi.
c. Steady state ground idle oil pressure limit is 45 to 80 psi (warm oil).

Inflight

During steady state flight, oil pressure limits are as follows:

IDLE	60 to 100 psi
95% rpm	95 to 145 psi
MIL	100 to 160 psi

AIRSPEED LIMITATIONS

The approximate maximum permissible airspeeds in smooth or moderately turbulent air with the arresting hook and landing gear retracted, flaps in AUTO, and any combination of air-to-air missiles are shown in figure 1-33. For exact airspeed limitations, refer to the Tactical Manual, A1-F18AC-TAC-000 (NWP 55-5-F/A18 Vol I).

Refer to Systems Limitations, figure 1-35, for additional airspeed limitations.

PROHIBITED MANEUVERS

GENERAL (ALL AIRPLANES)

a. Takeoff with any CAS axis failed.
b. Departure and zero airspeed tailslide.
c. Spin.
d. Flight in lightning or thunderstorms.
e. Yaw rates over 25°/second (yaw tone).
f. Full stick aileron roll over 360° bank angle change.
g. Dive over 45° with less than 1900 pounds fuel.
h. Zero G except transient.

Airspeed Limitations

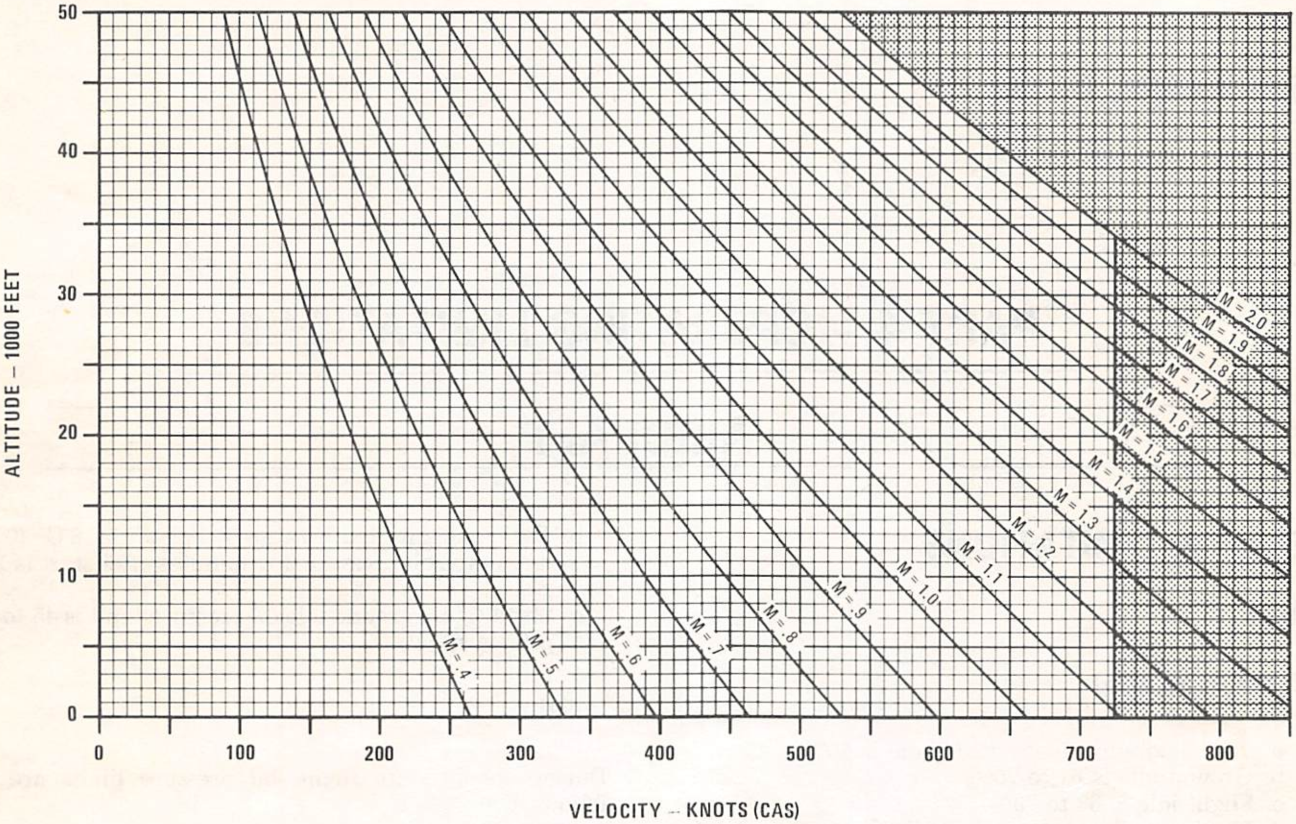

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Figure 1–33. Airspeed Limitations

i. Negative G for more than 5 seconds for airplanes thru 161924 (10 seconds for airplanes 161925 and up).
j. For airplanes thru 161924, less than 1 minute between negative G maneuvers.
k. For airplanes thru 161924, afterburner operation at less than +0.1G.
l. Pulling any FCS circuit breaker in flight except in an emergency.
m. Selection of gain ORIDE above 350 knots/Mach 1.0 or above 10° AOA.
n. Inflight selection of RCVY on the spin recovery switch except for actual spin recovery or as directed in NATOPS.
o. Flight without LAU 7A–5 wing tip launcher rails with power supply or approved ballast installed.

GENERAL (WITH 5.3.1 PROM)

a. Takeoff or flared landing with 90° crosswind component over 20 knots. Normal landing with 90° crosswind component over 15 knots.
b. Section takeoff and section landing.
c. Full stick aileron roll over 180° below 200 knots.
d. Over 1/2 lateral stick above 1.35 Mach.
e. Over 90° bank angle above 525 knots below 5000 feet AGL.
f. With speedbrake extended:
   1. More than 1/3 (33 pounds) rudder.
   2. Lateral control input above 350 knots.
g. Flap transition in close formation.
h. Loft/overhead maneuver below 10,000 feet AGL.
i. Carrier operation.
j. For airplanes thru 161519, landing with less than 1500 pounds total fuel plus 90 pounds/°C (50 pounds/°F) above 21°C (70°F) ambient temperature.
k. Speedbrake extension above 5.0G.

GENERAL (AFTER 7.0 PROM)

a. Takeoff or flared landing with 90° crosswind component over 30 knots. Normal landing with 90° crosswind component over 15 knots.
b. Section takeoff with any of the following conditions:
   1. Airplane gross weight over 45,000 pounds.
   2. CG forward of 19% MAC.
   3. Crosswind over 15 knots.
   4. Asymmetric load over 2000 foot–pounds not including missiles or pods on stations 1 or 9.
   5. Dissimilar loading except VERS, MERS, TERS, pylons, fuselage AIM–7's or wing tip AIM–9.
c. Actual or practice mode 1 approach.
d. Mode 1A approach in IMC.
e. Landing with autopilot engaged.
f. Use of RALT mode below 500 feet AGL.

FLAPS HALF OR FULL (ALL AIRPLANES)

a. Bank angle over 45°.

FLAPS HALF OR FULL (WITH 5.3.1 PROM)

a. Speedbrake extension.
b. More than 1/2 lateral stick.
c. More than 1/2 rudder.
d. Rolls with combined stick and rudder.

FLAPS HALF OR FULL (AFTER 7.0 PROM)

a. Cross control inputs above 150 knots with flaps FULL.

ANGLE–OF–ATTACK AND CG LIMITATIONS

If an angle–of–attack limitation is exceeded, take immediate corrective action.

FLAPS AUTO

For TF/A–18A airplanes above 0.8 Mach, the AOA limit is –6° to +15° and, between 0.7 and 0.8 Mach, the AOA limit is –6° to +20°.

The following table provide the AOA/CG limits for airplanes not otherwise restricted.
The fighter escort (FE) configuration is defined as a clean airplane with or without wing tip AIM–9, fuselage AIM–7, FLIR, LDT, or empty pylons/VER's on stations 2, 3, 5, 7, or 8.

With 5.3.1 PROM

CONFIG	AOA	CG %MAC
FE	–6°/+20°	26 to 27
	–6°/+35°	17 to 26

After 7.0 PROM

CONFIG	AOA	CG %MAC
FE	–6°/+25°	25 to 28
	Unrestricted	17 to 25

FLAPS HALF OR FULL

a. With 5.3.1 PROM, AOA over +12° or below 0° is prohibited.
b. After 7.0 PROM, AOA over +15° (with flaps HALF, excursion above +20°) or below 0° is prohibited.

WEIGHT LIMITATIONS

The maximum allowable gross weights are:

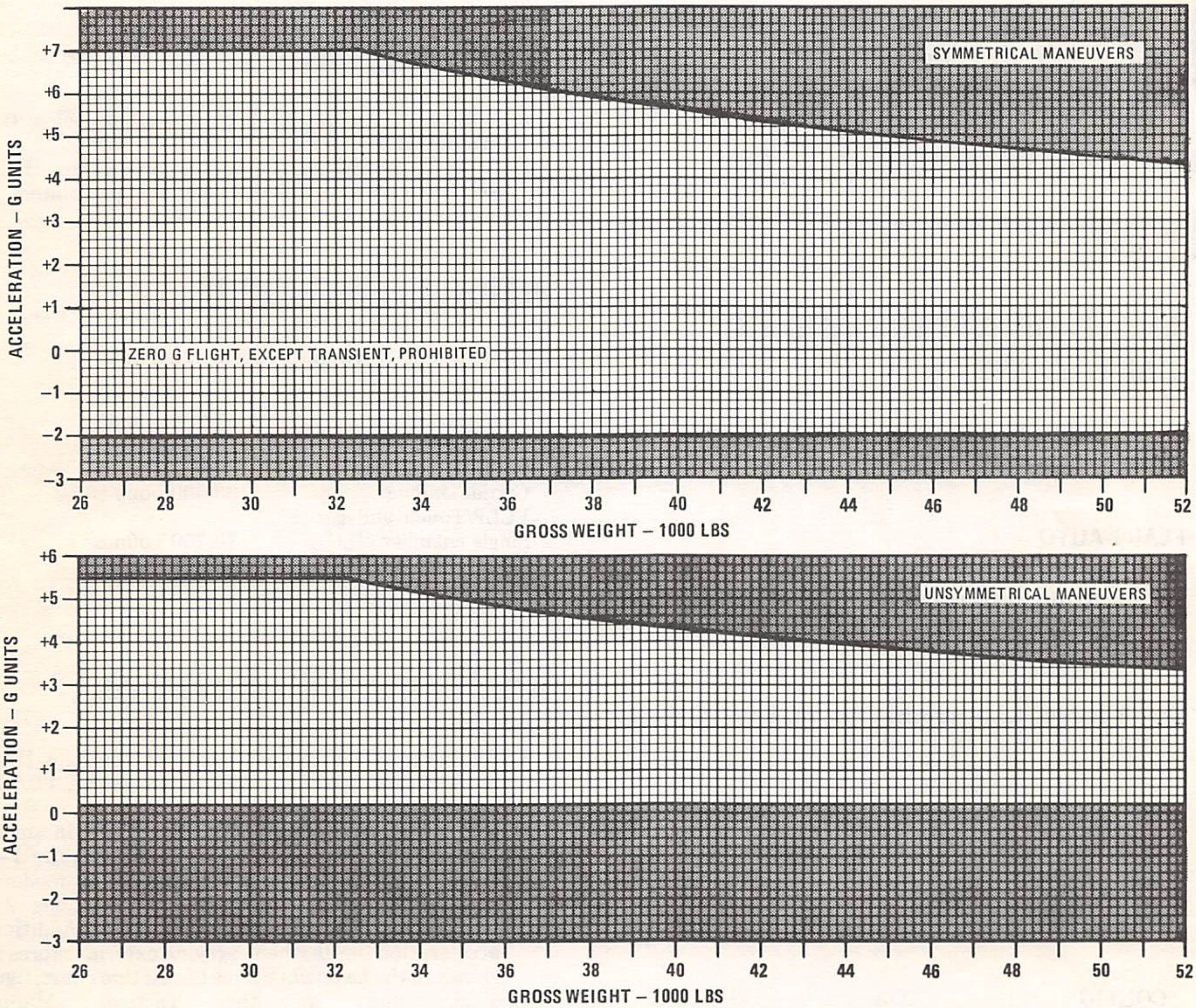
Field takeoff	51,900 pounds
Catapult	46,000 pounds
Field landing (flared)	39,000 pounds
Carrier landing	33,000 pounds
FCLP/Touch–and–go:	
Single chamber MLG	30,700 pounds
Dual chamber MLG	33,000 pounds

ACCELERATION LIMITATIONS

a. The permissible accelerations with the flaps HALF or FULL are +0.5G to +2.0G symmetrical, +0.5G to +1.5G unsymmetrical.
b. The maximum permissible accelerations in smooth air with the flaps AUTO are shown in figure 1–34. Avoid buffet at limit G when possible. In moderate turbulence, reduce deliberate accelerations 2.0G below that shown in figure 1–34. Additional acceleration limits when carrying external stores are shown in the External Stores Limitation chart, figure 1–36, and in the Tactical Manual, A1–F18AC–TAC–000 (NWP 55–5–F/A18 Vol I) and A1–F18AC–TAC–010 (NWP 55–5–F/A18 Vol. II)

Acceleration Limitations

BASIC AIRPLANE
WITH OR WITHOUT AIM-7 AND/OR AIM-9



NOTES

- For airplanes thru 161924, less than +0.1G is prohibited in afterburner.
- Maximum time at negative G is 5 seconds for airplanes thru 161924 (10 seconds for 161925 and up).
- For airplanes thru 161924, maintain 1 minute between successive negative G maneuvers.
- Speedbrake deflection above 5.0 G prohibited.
- See External Stores Limitations for additional G limitations.

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Figure 1–34. Acceleration Limitations

Systems Limitations

REFUELING PROBE	Extension – Retraction	300 knots
	Extended	400 knots
LANDING GEAR	Extension – Retraction	250 knots
	Emergency extension	180 knots
TRAILING EDGE FLAPS	HALF – FULL	250 knots
SPEED BRAKE (With 5.3.1 Prom)	Symmetrical flight	450 knots/Mach 0.9
	Unsymmetrical flight	350 knots
CANOPY	Open	60 knots

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Figure 1–35. System Limitations

EXTERNAL STORES

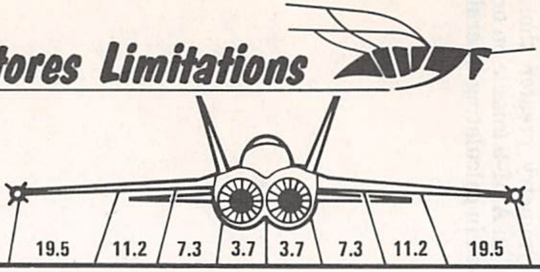
Only the external stores shown in the External Stores Limitations chart, figure 1–36, and the External Stores Limitations chart in the Tactical Manual, A1–F18AC–TAC–000 (NWP 55–5–F/A18 Vol. I) may be carried and released.

ASYMMETRIC STORE LOADING LIMITATIONS

With an asymmetric store loading between 6000 and 12,000 foot-pounds, do not exceed −6°/+20° AOA. With asymmetric store loadings between 12,000 foot-pounds and 22,000 foot-pounds, do not exceed −6°/+12° AOA. Flight with asymmetric loadings exceeding 22,000 foot-pounds is prohibited. Carrier operation with asymmetric loading over 15,000 foot-pounds is prohibited. Refer to Asymmetric Stores Landing procedure, section III, when operating with an asymmetry greater than 12,000 foot-pounds. The weight of an AIM-9 missile on or off station 1 or 9 should not be used in calculating lateral asymmetry.

External Stores Limitations

NA – NOT APPLICABLE
NE – NOT ESTABLISHED
LBA – LIMIT BASIC AIRCRAFT



STORE	LINE NUMBER	DISTANCE FROM AIRCRAFT CENTERLINE – FT									MAXIMUM KCAS OR IMN WHICHEVER IS LESS			ACCELERATION – G				ANGLE OF ATTACK LIMITS	CG LIMITS	CONFIGURATION WEIGHTS (LBS)	APPLICABLE NOTES
		STATION LOADING AND SUSPENSION									CARRIAGE	JETTISON		CARRIAGE		JETTISON					
		1	2	3	4	5	6	7	8	9		EJECTED	AUX RELEASE	SYM	UNSYM	EJECTED	AUX RELEASE				
315/330 Gal Fuel Tank (With 5.3.1 PROM)	1					○					635 1.6	575 1.6	575 1.6	–2.0 To +6.0 EMPTY LBA	+0.2 to +5.0	+0.5 to +2.0	1.0	–6°/ +20°	25/ 27	E454/429 F2596/2673	1,2,3, 6,7,8
																		–6°/ +35°	17/ 25		
	2			○				○										–6°/ +20°	17/ 24	E1194/1144 F5478/5632	1,2,3, 4,6,7, 8,9,10
(After 7.0 PROM)	3					○					635 1.6	575 1.6	575 1.6	–2.0 To +6.0 EMPTY LBA	+0.2 to +5.0	+0.5 to +2.0	1.0	–6°/ +25°	23.5 /28	E454/429 F2596/2673	1,2,7 (TF/A–18A only) 8
																		Unres-tricted	17/ 23.5		
	4			○				○										–6°/ +25°	17/ 27.5	E1194/1144 F5478/5632	1,2,5,7 (TF/A–18A only) 8,9,10

Figure 1–36. External Stores Limitations

CAUTION

All airspeeds greater than 425KCAS/0.75 IMN the maximum acceleration limits are reduced to 5.0G symmetric and 4.0G unsymmetric for wing stores weighing 1500 pounds or more.

NOTES

1. With full or partially full tank, make minimum descent rate landing. Only arrested landings with tanks empty are permitted.
2. Elliptical fuel tanks are cleared for unrestricted carrier operations. Fiberglass cylindrical tanks are cleared for carriage on wing stations only aboard non–flush deck catapult equipped ships. Fiberglass cylindrical tanks are cleared for carriage on all stations on flush deck catapult equipped carriers. Metal cylindrical tanks are not cleared for carrier operations.
3. Full stick aileron rolls above 10° AOA or over 180° bank angle change are prohibited with centerline store, 5.3.1 PROM and FLAPS AUTO.
4. Abrupt lateral control inputs, rolls over 180° bank angle change and over 1/2 lateral stick above 400 KCAS are prohibited except when tanks are empty.
5. Abrupt lateral control inputs and over 1/2 lateral stick if load factor is greater than 3G are prohibited except when tanks are empty.
6. Maximum Mach for TF/A–18A airplanes is 1.23.
7. The AOA limit above 0.8 Mach is –6° to +15° and between 0.7 and 0.8 Mach the AOA limit is –6° to +20°.
8. No abrupt lateral stick inputs with fuel in centerline tank on 161353 THRU 161519 AND 161524 THRU 161704.
9. Centerline tank optional.
10. Carrier operations with assymetric loadings in excess of 15,000 foot–pounds are prohibited.

SECTION II

INDOCTRINATION

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GROUND TRAINING SYLLABUS

MINIMUM GROUND TRAINING SYLLABUS

Initial ground training shall be conducted in accordance with the CNO approved syllabus. Follow-on ground training for each activity will vary according to local conditions, field facilities, requirements from higher authority, and the immediate Unit Commander's estimate of squadron readiness.

FLIGHT TRAINING SYLLABUS

TRAINING PHASES

Initial flight training, up to and including first solo shall be conducted in accordance with the CNO approved syllabus. Follow-on flight training should include airplane and weapon systems instruction, normal and emergency procedures, simulators (if available), open and closed book NATOPS tests, and evaluation of pilot performance. Local command requirements, squadron mission, and other factors will influence the actual flight training syllabus and the sequence in which it is completed.

PERSONAL FLYING EQUIPMENT

MINIMUM REQUIREMENTS

Refer to OPNAVINST 3710.7, for all standard flying equipment to be worn on every flight. All survival equipment will be secured in such a manner that it will be easily accessible and will not be lost during ejection or landing. This equipment shall be the latest available as authorized by Aircrew Personal Protective Equipment Manual (NAVAIR 13-1-6).

QUALIFICATIONS AND CURRENCY REQUIREMENTS

MINIMUM FLIGHT QUALIFICATIONS

Minimum flight hour requirements to maintain qualification after initial qualification in each specific phase will be established by the Unit Commanding Officer. Pilots who have more than 45 hours in model are considered current subject to the following criteria:

> Must have a NATOPS evaluation check with the grade of Conditionally Qualified, or better, within the past 12 months and must have flown 5 hours in model and made two takeoffs and landings within the last 90 days.
>
> Must have satisfactorily completed the ground phase of the NATOPS evaluation check, including COT/WST emergency procedures check (if available), and be considered qualified by the Commanding Officer of the unit having custody of the aircraft.

REQUIREMENTS FOR VARIOUS FLIGHT PHASES

SOLO

Not less than 5 hours first pilot time in model.

INITIAL NATOPS QUALIFICATION

Not less than 10 hours in model.

NIGHT

Not less than 10 hours in model.

CROSS COUNTRY

Have a minimum of 15 hours in model.

Have a valid instrument card

Have completed at least one night familiarization flight

CARRIER QUALIFICATION

Have a minimum of 50 hours in model, and meet the requirements set forth in LSO NATOPS manual.

CEILING/VISIBILITY REQUIREMENTS

Prior to the pilot becoming instrument qualified in the airplane, field ceiling/visibility and operating area weather must be adequate for the entire flight to be conducted in a clear air mass according to Visual Flight Rules. After the pilot becomes instrument qualified, the following weather criteria apply:

TIME IN MODEL (HR)	CEILING (Ft)/VISIBILITY (Mi)
10–20	800/2; 900/1-1/2; 1000/1
20–45	500/3; 600/2; 700/1
Over 45	Field minimums or 200/1/2 whichever is higher

Where adherence to these minimums unduly hampers pilot training, Commanding Officers may waive time-in-model requirements for actual instrument flight, provided pilots meet the following criteria:

Have a minimum of 10 hours in model

Completed 2 simulated instrument sorties

Completed 2 satisfactory Tacan penetrations.

FERRY SQUADRONS

Training requirements, check-out procedures, evaluation procedures, and weather minima for ferry squadrons are governed by the provisions contained in OPNAVINST 3710.6

WAIVERS

UNIT COMMANDERS AUTHORITY

Unit commanders are authorized to waive, in writing, minimum flight and/ or training requirements in accordance with OPNAVINST 3710.7 (Series).

SECTION III
NORMAL PROCEDURES

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PART 1 - FLIGHT PREPARATION

MISSION PLANNING

GENERAL

The pilot shall be responsible for the preparation of required charts, flight logs, navigation computations including fuel planning, checking weather and NOTAMS, and for filing required flight plans. Refer to section XI, Performance Data, to determine fuel consumption, correct airspeed, power settings, and optimum altitude for the intended flight mission. Planning data for specialized missions will be contained in the F/A-18A and TF/A-18A Tactical Manual (A1-F18AC-TAC-000).

FLIGHT CODES

The proper kind of flight classification and codes to be assigned individual flights are established by OPNAVINST 3710.7.

BRIEFING/DEBRIEFING

BRIEFING

The flight leader is responsible for briefing all flight members on all aspects of the mission to be flown. A briefing guide or syllabus card, as appropriate, will be used in conducting the briefing. Each flight member will maintain a kneepad and will record all flight numbers, call signs, and all other data necessary to assume the lead and complete the assignment. However, this does not relieve the flight leader of the responsibility for briefing all flight members in the operation and conduct of the flight. The briefing guide will include the following:

ASSIGNMENTS

Aircraft assigned, call sign, and deck spot when appropriate.

Engine start, taxi, and takeoff times

Visual signals and rendezvous instructions

MISSION

Primary

Secondary

Operating area

Control agency

Time on station or over target

WEAPONS

Loading

Safety

Arming, dearming

Duds

Special routes with ordnance aboard

Minimum pull-out altitude

Jettison area

COMMUNICATIONS

Frequencies

Radio procedure and discipline

Navigational aids

Identification and ADIZ procedures

WEATHER

Local area

Local area and destination forecast

Weather at alternate

High altitude weather for the jet stream, temperature, and contrail band width

NAVIGATION AND FLIGHT PLANNING

Takeoff speed

Takeoff distance

Abort distance

Crosswind effects

Climb out

Mission route, including ground controlling agencies

Fuel/oxygen management

Marshal

Penetration

GCA or CCA

Recovery

EMERGENCIES

Aborts

Divert fields

Bingo and low state fuel

Waveoff pattern

Ready deck

Radio failure

Loss of visual contact with flight

Ejection

SAR procedures

System failures

AIR INTELLIGENCE AND SPECIAL INSTRUCTIONS

Friendly and enemy force disposition

Current situation

Targets

Safety precautions

ECM and ECCM

OPERATING AREA BRIEFINGS

Prior to air operations in and around a new area, it is mandatory that a comprehensive area briefing be given including, but not limited to, the following:

Bingo Fields

Instrument approach facilities

Runway length and arresting gear

Terrain and obstructions

Emergency Fields

Fields suitable for landing but without required support equipment

Include information under Bingo fields

SAR Facilities

Type

Frequencies

Locations

DEBRIEFING

Postflight debriefing is an integral part of every flight. The flight leader should review the entire flight from takeoff to landing, including not only errors and poor techniques, but also the methods of correcting them. Also, the flight leader shall cover any deviations from standard operating procedures.

PART 2 - SHORE BASED PROCEDURES

PREFLIGHT CHECK

LINE OPERATIONS

The yellow sheet must be checked for flight status, configuration, armament loading, and servicing prior to manning the aircraft. At least the ten previous B sections should be reviewed for discrepancies and corrective action. Weight and Balance clearance is the responsibility of the maintenance department.

EXTERIOR INSPECTION

The exterior inspection is divided into 21 areas. The inspection begins at the left fuselage and continues around the aircraft in a clockwise direction. Check doors secure and be alert for loose fasteners, cracks, dents, leaks, and other general discrepances.

1. Nose landing gear - CHECK
   a. Tires, wheels, and strut - CONDITION
   b. Tire pressure - 150 PSI (ashore) 350 PSI (afloat)
   c. Launch bar and holdback - CONDITION
   d. Nosewheel steering assembly - CONDITION
   e. Drag brace - PIN REMOVED
   f. Strut pressure - CHECK (two indicators)
   g. Retract actuator - CONDITION
   h. Taxi and approach lights - CONDITION
   i. Tiedown rings - SPRING CONDITION
2. Nose wheelwell - CHECK
   a. Emergency brake accumulator pressure - CHECK
   b. Digital display indicator - NO FLAGS
   c. APU emergency shutdown switch - NORMAL
   d. Doors and linkages - CONDITION
3. Nose section (left side) - CHECK
   a. Gun - PREFLIGHT
   b. Pitot static probe - CONDITION
   c. Pitot static drains (5) - CLOSED
   d. AOA vane - CONDITION
   e. Forward UHF antenna - CONDITION
   f. Radome - SECURE (2 points)
4. Nose section (top) - CHECK
   a. Gun blast diffuser and gun port - CLEAR
5. Nose section (right side) - CHECK
   a. Radome - SECURE (2 points)
   b. AOA vane - CONDITION
   c. Pitot static probe - CONDITION
   d. Refueling receptacle cover - INSTALLED (door 8R)
6. Right fuselage - CHECK
   a. SMS processor - CHECK CODES, DOOR 14R CLOSED/SECURE
   b. Aft UHF antenna - CONDITION
   c. Engine intake duct - CLEAR
   d. ECS intake - CLEAR
   e. Chaff/flare dispenser - PREFLIGHT (if required)
7. AIM-7 or LST strike camera - PREFLIGHT
8. Fuel air heat exchanger intake - CLEAR AND CONDITION
9. Right main wheelwell - CHECK
   a. Doors and linkages - CONDITION
   b. APU accumulator - PRESSURE, TEMPERATURE, PISTON POSITION
   c. Landing gear downlock and retract actuators - CONDITION
   d. Downlock pin - REMOVED
   e. Hydraulic filter indicators - NOT POPPED
10. Right main landing gear - CHECK
   a. Tire - TREAD WEAR, PRESSURE 200 PSI (ashore) 350 PSI (afloat)
   b. Brake wear indicator - CHECK
   c. Shrink links and planing links - CONDITION
   d. Shock strut pressure - CHECK
   e. Tiedown rings and springs - CONDITION
11. Right wing - CHECK
   a. Leading edge flap - CONDITION
   b. Pylons and external stores - PREFLIGHT
   c. Navigation lights - CONDITION
   d. Wingfold area - CONDITION
   e. AIM-9 - PREFLIGHT
   f. Aileron and trailing edge flap - CONDITION
12. Right aft fuselage - CHECK
   a. Hydraulic reservoir gage - CHECK
   b. Vertical stabilizer and rudder - CONDITION
      (1). Navigation, formation, and strobe lights - CONDITION
      (2). Fuel vent port and dump mast - CLEAR
   c. Stabilator - CONDITION
   d. Exhaust nozzle, afterburner section, turbine blades - CONDITION
13. Arresting hook area - CHECK
   a. Arresting hook - CONDITION (pin removed)
   b. Hook snubber pressure - CHECK
14. Left aft fuselage - CHECK
   a. Exhaust nozzle, afterburner section, turbine blades - CONDITION
   b. Stabilator - CONDITION
   c. Vertical stabilizer and rudder - CONDITION
      (1). Fuel vent port and dump mast - CLEAR
      (2). Formation and strobe lights - CONDITION
   d. Hydraulic reservoir gage - CHECK
15. Aft fuselage underside - CHECK
   a. APU intake and exhaust - CLEAR
   b. ATS exhaust - CLEAR
16. Left wing - CHECK
   a. Trailing edge flap and aileron - CONDITION
   b. AIM-9 - PREFLIGHT
   c. Navigation lights - CONDITION
   d. Pylons and external stores - PREFLIGHT
   e. Leading edge flap - CONDITION
17. Left main landing gear - CHECK
   a. Tire - TREAD WEAR, PRESSURE 200 PSI (ashore) 350 PSI (afloat)
   b. Brake wear indicator - CHECK
   c. Shrink links and planing links - CONDITION
   d. Shock strut pressure - CHECK
   e. Tiedown rings and springs - CONDITION

18. Left main wheelwell – CHECK
    a. Doors and linkages – CONDITION
    b. Landing gear downlock and retract actuators – CONDITION
    c. Downlock pin – REMOVED
    d. Hydraulic filter indicators – NOT POPPED
19. Fuel air heat exchanger intake – CLEAR AND CONDITION
20. AIM–7 or FLIR – PREFLIGHT
21. Chaff/flare dispenser – PREFLIGHT
22. Forward fuselage underside – CHECK
    a. Loose fasteners and fluid leaks – CHECK
    b. Centerline station/store – PREFLIGHT
    c. Fuselage fuel cavity drains – CHECK
23. Left fuselage – CHECK
    a. Engine intake duct – CLEAR
    b. ECS intake – CLEAR
    c. Total temperature probe – CONDITION

BEFORE ENTERING COCKPIT

1. Boarding ladder – SECURE (2 points)
2. Airplane upper surfaces – CONDITION
3. Windshield – SECURE
   Push up on windshield bow to make sure the windshield is secure.
4. Ejection seat safe/arm handle – SAFE
5. Ejection seat – PREFLIGHT
   a. Ejection seat manual override handle – Check handle full down and manual override initiator maintenance pin removed from sear.
   b. Time release mechanism trip rod – Check time release mechanism trip rod secured to bulkhead and engaged in time release mechanism. Check red color band on trip rod not visible. Check maintenance pin removed from sear.
   c. Right trombone assembly – Hoses connected and retaining pin installed and safety wired.
   d. Canopy quick disconnect – Check engaged and red band not visible.
   e. Survival kit release handle – Check full down.
   f. Leg restraint lines – Check lines secured to cockpit floor, lines not twisted, and line pins locked into front of ejection seat.
   g. Ejection seat firing initiators – Check firing linkage connected to sears.
   h. Survival kit emergency oxygen – Check pressure gage, emergency oxygen green ring stowed inboard of left thigh cushion, and automatic emergency oxygen operating cable lanyard connected to cockpit floor.
   i. Rocket motor initiator – Check initiator cable lanyard connected to drogue gun trip rod without excessive cable hanging from initiator housing. Initiator sear installed with cable lever assembly link inserted, maintenance pin removed from sear. Left trombone assembly connected with quick release pin inserted and safety wired.
   j. Drogue gun trip rod – Check drogue gun trip rod secured to bulkhead and engaged in drogue gun with maintenance pin removed from sear. Check that red color band on trip rod is not visible.
   k. Top latch mechanism – Check that top latch plunger and locking indicator is flush with the end of the top latch mechanism housing and the main beam.

WARNING

If the top latch mechanism check does not meet the outlined requirements, the seat could come loose on the mounting rails.

   l. Catapult firing head assembly – Check hoses and firing head connected, and retaining pin installed and safety wired.
   m. Scissor shackle tie–down – Check drogue withdrawal line connected to the drogue slug. Check forward flap on top of all other flaps and shackle tie routed through eyelet in top flap and routed through both drogue shackle and extender strap. Check scissor mechanism tied securely to top of parachute container. Check drogue shackle engaged in scissors, and scissors release plunger extended against moveable scissor arm with plunger pin visible on top of scissors plunger.
   n. Parachute risers – Check risers routed down forward face of the parachute container and routed behind retaining strap.
   o. Radio beacon lanyard – Check lanyard secured to seat bucket.
   p. Check lap belts secure. Pull up strongly on each belt to make sure bolt fittings are engaged in seat. Check front end of survival kit secured to seat. Pull up on front end of kit to test security.

CAUTION

If any portion of the survival kit cushion is moved to gain access to components underneath, unsnap cushion retaining snaps by a forward/up motion (not back/aft) and resnap by an aft/down motion.

For solo flight in TF/A–18A aircraft –

6. Rear cockpit – SECURED
   a. Check ejection seat safe/arm handle in SAFE.
   b. Secure all loose items, including harnessing.
7. Command selector valve – SECURED IN SOLO POSITION
   Check sequence selector collar installed

INTERIOR CHECK

CAUTION

Do not place any item on the glare shield, as scratching the windshield is probable.

1. Harness and rudder pedals – SECURE/ADJUST
   Fasten and secure leg restraint garters and lines. Check leg garters buckled and properly adjusted with hardware on inboard side of the legs. Check that lines are secured to seat and floor and not twisted. Check that leg restraint lines are routed first through the thigh garter ring, then through the lower garter ring, and then routed outboard

of the thigh garter ring before the lock pins are inserted into the seat just outboard of the snubber boxes. Attach parachute risers to harness buckles. Connect and adjust lap belt straps. Connect oxygen, G suit, and communications leads. Check operation of shoulder harness locking mechanism.

WARNING

- The leg restraint lines must be buckled at all times during flight to ensure that the legs be pulled back upon ejection. This will enhance seat stability and will prevent leg injury by keeping the legs from flailing following ejection.
- Failure to route the restraint lines properly through the garters could cause serious injury during ejection/emergency egress.

2. Oxygen – ON AND CHECK FLOW

Left console –

1. Circuit breakers (4) – IN
2. Manual canopy handle – STOWED
3. Nuclear weapon consent switch – DISABLE
4. Mission computer and hydraulic isolate switches – NORM
5. Comm 1/IFF antennas – AUTO/BOTH
6. Communication panel – SET
   a. Relay, cipher, squelch and guard – OFF
   b. ILS – SET FREQUENCY/UFC
   c. Master, mode 4, and crypto switches – NORM/OFF/NORM
7. Volume control panel – SET
8. Gain switch – NORM
9. Refuel probe switch – RETRACT
10. External tanks switches – NORM
11. Dump switch – OFF
12. Internal wing switch – NORM
13. External lights – SET
14. Throttles – OFF
15. Parking brake – SET
16. Landing/taxi switch – OFF
17. Anti-skid switch – ON
18. Flap switch – AUTO
19. Selective jettison knob – SAFE
20. Landing gear handle – DOWN
21. Canopy jettison handle – FORWARD

Instrument panel –

1. Master arm switch – SAFE
2. FIRE and APU FIRE warning lights – NOT PRESSED
   If the light(s) is/are pressed, approximately ⅛ inch of yellow and black stripes will be visible around the outer edges of the light(s).
3. DDI, HI, and HUD – OFF
4. Altitude source – SELECT
5. Attitude source – AUTO
6. Comm 1 and 2 knobs – OFF
7. ADF switch – OFF
8. ECM mode – OFF
9. Dispenser select knob – OFF
10. Auxiliary release switch – NORM
11. Clock – CHECK AND SET
12. Attitude reference indicator – UNCAGE
13. IR coolant switch – OFF
14. Spin recovery switch – GUARD DOWN/OFF

Right console –

1. Circuit breakers (4) – IN
2. Arresting hook handle – UP
3. Wing fold handle – SAME AS WING POSITION
4. FCS cool switch – NORM
5. Radar altimeter – OFF
6. Generator switches – NORM
7. Battery switch – OFF
8. ECS system – SET
   a. Mode switch – AUTO
   b. Temperature knob – 10 O'CLOCK
   c. Cabin pressure switch – NORM
   d. Bleed air knob – NORM and DOWN
   e. Engine anti-ice switch – OFF
   f. Pitot anti-ice switch – AUTO
   g. Defog handle – MID RANGE
9. Windshield anti-ice switch – OFF
10. Interior lights – AS DESIRED
11. Sensors – OFF
12. KY-58 panel – SET
13. AN/AWB-3(V) monitor control – SET

ENGINE START

With an external power start, all electrical systems except those on external power switch 3 are operative. With a battery start, power is available to operate the APU and engine fire warning systems, the intercom system between the pilot and the ground, the cockpit utility light and EMI. If external air is used for engine start, place the bleed air knob OFF.

When the engine crank switch is moved to L or R, the air turbine starter control valve (ATSCV) opens and the air turbine starter (ATS) rotates the engine thru the AMAD. Engine rotation is apparent almost immediately and will be seen on the tachometer. During operation below flight idle, the nozzles may go closed or oscillate. After the engine lights-off and accelerates to approximately 60% rpm, the engine crank switch returns to OFF. After both generators are on the line, the APU will run for one minute, and then shut down.

The right engine is normally started first in order to provide normal hydraulics to the brakes. Rapid stick movement with only the right engine running may cause the priority valve to cut off brake pressure.

Airplanes 161702 and up –

1. Battery status – CHECK
   a. Battery switch – ORIDE
   b. E BATT voltage – CHECK
      After battery switch in ORIDE for minimum of

5 seconds, check for minimum voltage of 23.5 volts.

c. Battery switch – ON

d. U BATT voltage – CHECK

After battery switch in ON for minimum of 5 seconds, check for minimum voltage of 23.5 volts.

With external electrical power –

1. External power switch – RESET
2. Switch 1, 2, and 4 – B ON
3. DDI, HI, and HUD – ON
4. Comm 1, 2, and ADF – AS DESIRED
5. Warning and caution lights – TEST
6. Inertial navigation system – ENTER WAYPOINTS DESIRED

All starts –

1. Battery switch – ON (if not previously ON)
2. Fire warning – TEST A and B

   Observe left and right FIRE, APU FIRE, L BLEED, and R BLEED lights on in each test position. If DDI is on, observe L and R BLD OFF cautions are displayed. Ensure all voice alerts are operating.
3. Control stick – CYCLE
4. APU ACCUM caution light – OFF
5. APU switch – ON (READY light within 30 seconds)

   If fire or overheat condition is detected, the APU will shut down.
6. Engine crank switch– R
7. Stabilator feedback linkage – CHECK

   After both stabilators fair to the neutral position, move stick slowly forward or aft and release. Both stabilators shall move smoothly and symmetrically with stick input and return to neutral when stick is released.
8. Right throttle – IDLE (15% rpm minimum)

   Maximum EGT during start is 815°C.

CAUTION

If ATS caution is on when the right DDI comes on, shut down engine to avoid starter damage.

9. Right DDI – ON (if not previously ON)
10. EMI – CHECK

    After engine start, it may be necessary to advance power above IDLE to get the ECS turbine started.

Ground idle –

N_2	61 – 72%
EGT	190 – 590°C
Nozzle	73 – 84%
Fuel flow	600 – 900 pph
Oil pressure (warm oil)	45 – 80 psi

11. Bleed air knob – CYCLE THRU OFF TO NORM

    The bleed air shutoff valves close during the fire warning test and the bleed air knob must be cycled thru OFF to NORM with ac power on to reset the valves.
12. Warning and caution lights – TEST
13. Left engine – START

    If a crossbleed start is desired:

    a. APU switch – OFF
    b. Engine rpm – 80% MINIMUM
    c. Fuel flow – 1900 PPH MINIMUM
14. Engine crank switch – L
15. Left throttle – IDLE (15% rpm minimum)
16. Engine crank switch – CHECK OFF
17. EMI – CHECK
18. External electrical power – DISCONNECT (if required)

BEFORE TAXI

1. On DDI FCS display – VERIFY STAB X's (FAILED) IN CHANNEL 1 AND 2
2. FCS reset button – PUSH

If no reset –

a. T.O. trim button – PUSH (note TRIM advisory)

b. FCS exerciser mode – INITIATE (after 7.0 PROM)

Push BIT and RESET simultaneously

If still no reset –

c. FCS circuit breakers – PULL 4 CHANNELS

d. Wait 10 seconds

e. FCS circuit breakers – RESET

f. FCS reset button – PUSH

3. Generators – TEST

   a. Right generator switch – OFF (fuel gage operative)
   b. Left generator switch – OFF (BATT SW caution on) (Do steps c and d within 7 seconds)
   c. Battery switch – ORIDE (BATT SW caution on, ADI OFF flag out of view)
   d. Right generator switch – NORM (oxygen gage operative)
   e. Left generator switch – NORM
   f. Battery switch – ON (BATT SW caution off)
   g. FCS – CHECK DDI DISPLAY
4. APU – VERIFY OFF
5. FCS reset button and paddle switch – ACTUATE SIMULTANEOUSLY
6. Waypoint zero and magnetic variation – CHECK
7. Inertial navigaton system – ALIGN (parking brake set)
8. DDI, HI, HUD, and UFC avionics – ON

   If the DDI or HI do not come on they may not be properly secured to the instrument panel. Do not launch with improperly secured DDI or HI.
9. Radar altimeter – ON
10. Radar – OPERATE
11. Wingfold – SPREAD AND LOCK
12. Trim – CHECK

    Check pitch, roll, and yaw trim for proper movement and then set for takeoff. After 7.0 PROM, if takeoff trim is not set, full leading edge down stabilator movement may not be available and takeoff distance will increase.

13. T.O. trim button – PRESS UNTIL TRIM ADVISORY DISPLAYED

    With 5.3.1 PROM, if a TRIM advisory does not appear but, without manual trim, the stabilators are symmetrical between −3° and −5°, the rudders are symmetrically toed in, and there is no FCSA DEGD or FCSB DEGD, the airplane is properly trimmed for takeoff. After 7.0 PROM, if a trim advisory does not appear, abort.
14. Fuel quantity gage – BIT/SET BINGO
15. Altimeter – SET
16. FCS CAS system – CHECK
    a. Flaps – FULL 24 aft 10 fwd (10/10 diff)
    b. Flaps – AUTO 21 aft 10 fwd (7/7 diff)
    c. Differential trailing edge flaps – CHECK
    d. Flaps – HALF
17. Air refueling probe, speed brake, launch bar, and arresting hook – CYCLE
18. Inertial navigation system – CHECK
    a. Alignment – OK
    b. Select – INS NORM (CV OR GND)
    c. Waypoints – CHECK
19. Mission data – ENTER
20. BIT – NOTE DGD/FAIL
21. Weapons/sensors – AS REQUIRED

TAXI

As airplane starts to roll, apply brakes to check operation. When clear, check nosewheel steering in both directions in the high mode to ensure proper operation. At high gross weight, make all turns at minimum practicable speed and maximum practicable radius. Wet brakes have reduced braking capability. This can be as much as a 50% loss. Dragging the brakes during taxi can accelerate drying time.

1. Normal brakes – CHECK
2. Nosewheel steering – CHECK

TAKEOFF

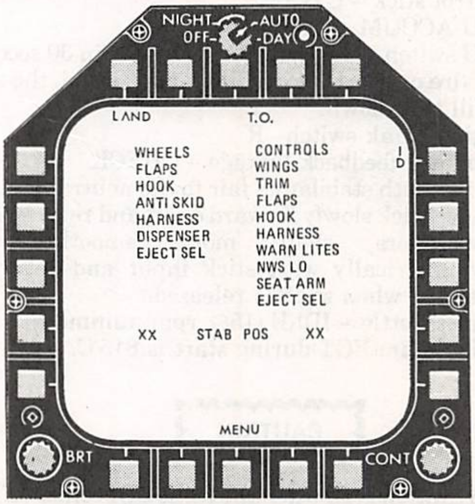
BEFORE TAKEOFF

1. Canopy – CLOSED
2. IFF – ON
3. Parking brake handle – FULLY STOWED
4. MENU checklist – COMPLETE
5. Engines – MIL CHECK (if desired)
    a. N_2 rpm – 92 to 100%
    b. EGT – 715 to 830°C (852°C MAX)
    c. FF – 6000 to 9000 pounds per hour
    d. NOZ POS – 0 to 57%
    e. OIL PRESS – 100 to 160 psi
    f. Afterburner – CHECK (if desired)

NORMAL TAKEOFF

Ensure the speed brake is retracted. The aircraft should be aligned with the centerline of the runway for individual takeoffs. When in position, roll forward slightly to center the nose wheel and select low gain nosewheel steering. As the takeoff roll is begun, advance throttles to MIL power and check EGT and RPM. If an afterburner takeoff is desired, afterburner is selected by moving both throttles into the afterburner range and advancing smoothly to MAX power. If one afterburner fails to light or blows out during takeoff, the resulting power loss is significant. Sufficient directional control is available with the rudder and nosewheel steering to continue the takeoff with asymmetric power. The decision to abort or continue the takeoff will depend on existing circumstances; external stores configuration, runway remaining, and the characteristics of the afterburner failure since it may indicate problems with the basic engine. Nosewheel steering is used to maintain directional control throughout the takeoff roll. Differential braking is not recommended since nosewheel steering is available and is more effective. Also, the drag of the brakes will increase the length of the takeoff roll.

Checklist Display



NOTES

- The XX values represent degrees and are followed by NU (nose up) or ND (nose down). The values may range from 24 NU to 10 ND.
- EJECT SEL is displayed on TF/A–18 aircraft only

18AC–NFM–10–(73)

Figure 3-1. Checklist Display

The location of the main landing gear well aft of the C.G. will not allow the aircraft to be rotated early in the takeoff roll. The normal rotation technique is to position the stick aft of neutral accelerating through 100 knots. Nosewheel lift–off speed will depend upon weight and C.G.; however, the aft stick should be held until reaching 6 to 8° nose high attitude. Main gear lift–off follows shortly, and a forward adjustment of stick will be necessary to maintain the desired attitude.

For a minimum run takeoff, full afterburner power is used. Accelerating through 100 knots, full aft stick is applied until the airplane begins to rotate, at which time the stick is adjusted to maintain a 10 to 12° pitch attitude.

Once a positive climb rate is established, ensure the gear handle light is out and retract the gear. Accelerate to the appropriate climb speed.

HEAVY GROSS WEIGHT TAKEOFF

For gross weight, above 45,000 pounds, trim the stabilator to −10° (NU). The minimum run takeoff technique is recommended.

CROSSWIND TAKEOFF

The initial portion of the crosswind takeoff technique is the same as the normal takeoff. Aft stick pressure should not be applied until approaching lift–off speed.

Do not assume an immmediate wing low attitude in order to counteract for wind drift; the pilot cannot properly judge the wing tip ground clearance on a swept wing airplane.

FORMATION TAKEOFF

Refer to Formation Flight, part 4, this section.

AFTER TAKEOFF

When definitely airborne –

1. Landing gear – UP
2. Flaps – AUTO
3. External transfer switch – AS DESIRED
4. IFF – AS DESIRED

CLIMB

Due to the rapid climb capability of the airplane, it may be necessary to reduce power to allow time to comply with ATC requirements. For visibility over the nose, maintain 350 knots to 10,000 feet. For optimum climb performance, refer to section XI, part 3.

CRUISE

For optimum cruise performance, refer to section XI, part 4.

CAUTION

When using JP–4 fuel and ambient temperature at takeoff exceeds 85°F, idle power decelerations between 1.23 and 0.9 Mach may result in engine flameout.

LANDING

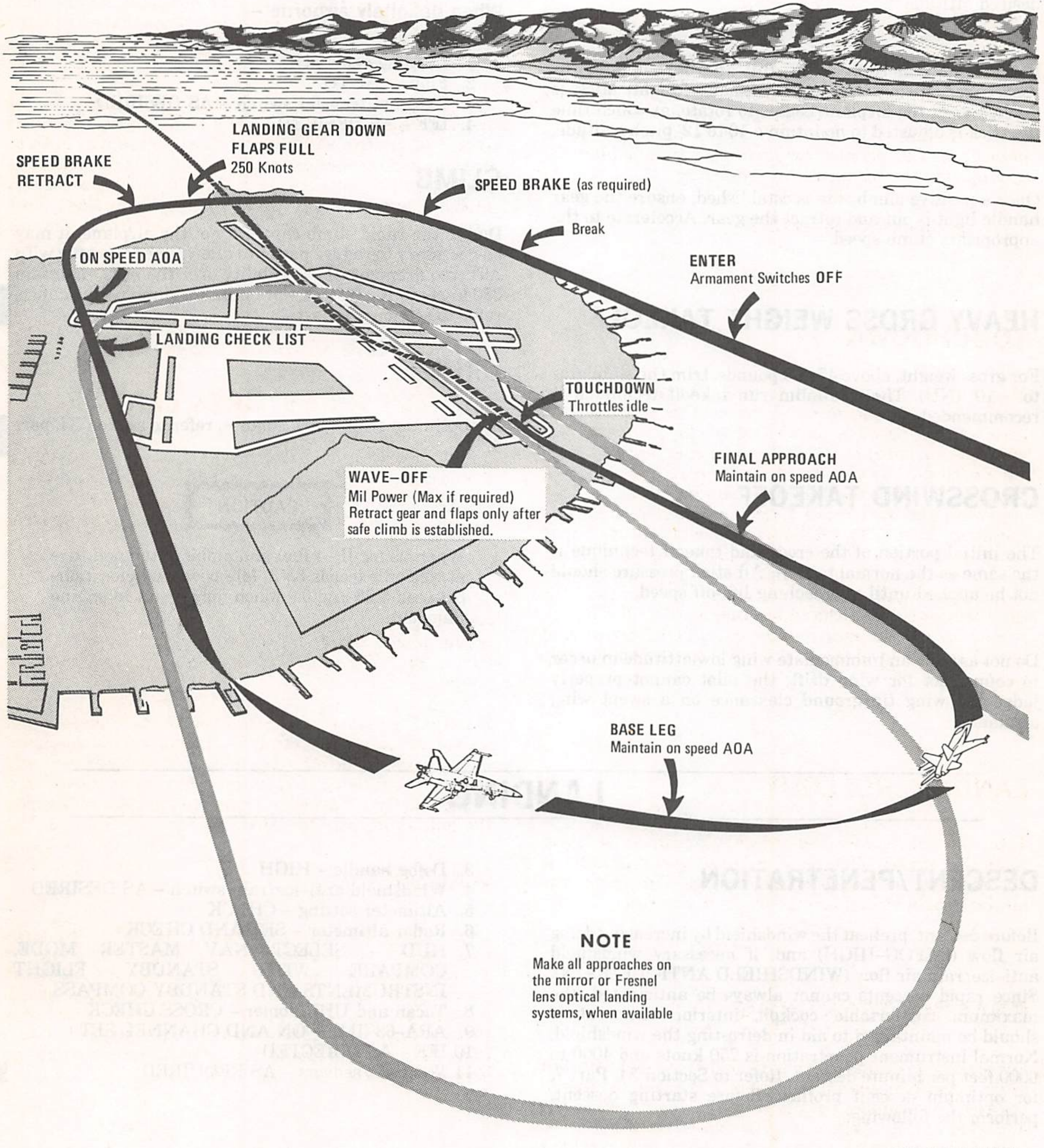
DESCENT/PENETRATION

Before descent, preheat the windshield by increasing defog air flow (DEFOG–HIGH) and, if necessary windshield anti–ice/rain air flow (WINDSHIELD ANTI–ICE/RAIN). Since rapid descents cannot always be anticipated, the maximum comfortable cockpit interior temperature should be maintained to aid in defrosting the windshield. Normal instrument penetration is 250 knots and 4000 to 6000 feet per minute descent. Refer to Section XI, Part 7, for optimum descent profiles. Before starting descent, perform the following:

1. Engine anti–ice – AS DESIRED
2. Pitot heat – AUTO
3. Defog handle – HIGH
4. Windshield anti–ice/rain switch – AS DESIRED
5. Altimeter setting – CHECK
6. Radar altimeter – SET AND CHECK
7. HUD – SELECT NAV MASTER MODE, COMPARE WITH STANDBY FLIGHT INSTRUMENTS AND STANDBY COMPASS
8. Tacan and UHF homer – CROSS CHECK
9. ARA–63 (ILS) – ON AND CHANNEL SET
10. IFF – AS DIRECTED
11. Weapons/sensors – AS REQUIRED

Field Landing Pattern

TYPICAL



NOTE

Make all approaches on the mirror or Fresnel lens optical landing systems, when available

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Figure 3–2. Field Landing Pattern Typical

APPROACH

Refer to figure 3-2. Enter the pattern as prescribed by local course rules. At the break, reduce thrust and extend the speed brake (if required). As the airspeed decreases through 250 knots, lower the landing gear and place the flap switch to FULL and ensure that speed brake is retracted. Retract speed brake, if extended. Decelerate to on-speed, and compare airspeed and angle of attack. Complete the DDI landing checklist. Roll into the base leg and establish a rate of descent, maintaining on-speed AOA. Rate of descent can be established using the velocity vector on the HUD to set the glide-scope. Avoid overcontrolling the throttles as thrust response is immediate. Compensate for crosswind by crabbing the aircraft into the wind on final approach.

1. Landing checklist - COMPLETE

TOUCHDOWN

Maintain approach attitude and thrust setting to touchdown using the mirror or make a firm touchdown at least 500 feet past the runway threshold. At touchdown, place the throttles to IDLE. The airplane tends to align itself with the runway. Small rudder corrections may be required to keep the airplane tracking straight. If a crosswind lifts the upwind wing, use lateral stick to level the wings. With 5.3.1 PROM, excessive lateral stick may cause a lateral PIO. On all airplanes, with a flared minimum-descent-rate landing, the weight-on- wheels switches may not actuate immediately. In this case, the throttles cannot be reduced to ground IDLE, the rolling surface to rudder interconnect will still be active, and lateral stick to level the wings will cause an undesirable rudder input.

LANDING ROLLOUT

Track down the runway centerline using rudder pedals to steer the aircraft directionally.Aerodynamic braking is not recommended. Use wheel braking only after the airplane main wheels are firmly on the runway.

BRAKING TECHNIQUE

For maximum braking with anti-skid above 40 knots, full brake pedal pressure (approximately 125 pounds) should be used. Longitudinal pulsing will probably be felt as the anti-skid cycles. As the airplane decelerates below 40 knots full brake pressure should be relaxed to prevent the wheels from locking. Below approximately 20 knots anti-skid is inoperative and brakes must be judiciously applied to prevent tire skid.

CROSSWIND LANDING/WET RUNWAY LANDING

With a 90° crosswind component of 15 knots or less, fly a crabbed normal approach. With a 90° crosswind component over 15 knots, fly a crabbed approach but flare for landing. In either case, take out half the crab just before touchdown. If the crosswind component is high, the upwind wing will tend to rise. Lateral controls are effective in keeping the wings level.

For wet runway landings, reduce gross weight to the minimum practical. Concentrate on landing on-speed or slightly slow. This will keep the total energy that must be dissipated to a minimum. Use anti-skid to minimize landing roll. Operations on wet or flooded runways may produce hydroplaning throughout the landing speed range. Consider an arrested landing. Total hydroplaning speed of the main landing gear tires inflated to 200 psi is 125 knots, and, for nose gear tires inflated to 150 psi, is 110 knots.

If directional control problems occur after touchdown, waveoff and make an arrested landing.

ASYMMETRIC STORES LANDING

Landing with asymmetric external stores up to 12,000 foot-pounds of lateral asymmetry requires no special considerations. Above 12,000 foot-pounds of lateral asymmetry, AOA must be kept below 12° to prevent uncommanded sideslip.

The inboard station is 7.3 feet from the airplane centerline and the outboard station is 11.2 feet from the airplane centerline. A lateral asymmetry of 12,000 foot-pounds occurs with 1,636 pounds of asymmetry on an inboard station or 1,070 pounds of asymmetry on an outboard station.

If lateral asymmetry exceeds 12,000 foot-pounds, do not exceed 12° AOA. Fly straight-in approach at optimum approach speed. Do not apply cross controls and make only smooth, coordinated rudder and lateral stick inputs. In a crosswind, fly a crabbed approach to touchdown. Cushion the touchdown with thrust.

WAVEOFF

Do not delay the decision to take a waveoff to the point that control of the landing or rollout is in jeopardy. Takeoff distances at MIL or MAX power are short provided the airplane has not decelerated to slow speed. Advance the throttles to MIL or MAX as required to either stop the sink rate or takeoff and maintain angle of attack. Raise the landing gear and flaps only after a safe climb has been established.

POSTFLIGHT

AFTER LANDING

Do not taxi with the right engine shut down. With the right engine shut down, only the accumulators provide hydraulic power for nosewheel steering and brakes.

When clear of active runway –

1. Ejection seat – SAFE
2. Flap switch – AUTO
3. Trim – TAKEOFF

HOT REFUELING

When refueling external tanks, they will refuel slowly until the internal tanks are full. Do not hot refuel with the right engine shut down. With the right engine shut down, only the accumulators provide hydraulic power for nosewheel steering and brakes.

1. Internal wing switch – AS REQUIRED
2. Fuel panel – set
3. Refueling – INITIATE
4. Refueling pilot valves pre–check – PERFORM
   a. Refueling supervisor notifies pilot – ACTIVATING PRE–CHECK NOW
   b. Rapid increase then stabilization of fuel quantity indication for 60 seconds

NOTE

The fuel quantity indicator must stabilize within 45 seconds after initiating pre–check and must not increase more than 100 pounds in the following 60 seconds.

If pre–check fails –

5. Refueling – STOP IMMEDIATELY

WARNING

A failed or leaking refueling pilot valve causes rapid overfilling of the fuel overflow/vent tank, fuel spillage from the vent mast(s) and possible fire if fuel spills on hot engine components.

NOTE

The pre–check system may require as long as 45 seconds to close the refueling pilot valves. Closing of the valves is indicated by a rapid decrease in the refueling rate. An increase of more than 100 pounds fuel quantity after allowing the valves time to close (45 seconds maximum) indicates failure of one or more valves to close.

After refueling is complete –

5. Taxi clear as directed by refueling supervisor

BEFORE ENGINE SHUTDOWN

1. Auto BIT – INITIATE/RECORD DGD, FAIL
2. BLIN codes – RECORD (before 7.0 PROM)
3. INS – OFF (10 seconds before engine shutdown)
4. Sensors, weapon systems, avionics and UFC – OFF
5. DDI, HI, and HUD – OFF
6. Comm 1 and 2 – OFF
7. Exterior and interior lights – OFF
8. Oxygen switch – OFF
9. Canopy – OPEN

ENGINE SHUTDOWN

1. Battery switch – OFF
2. Throttles – OFF

TF/A-18A REAR COCKPIT PROCEDURES

WARNING

Flight in the rear seat is limited to crewmembers with buttock–leg length less than 44 inches and buttock–knee length less than 25 inches.

BEFORE ENTERING COCKPIT

1. Ejection seat safe/arm handle – SAFE
2. Ejection seat – PREFLIGHT PER FWD COCKPIT CHECKLIST

INTERIOR CHECK

1. Harness and rudder pedals – SECURE/ADJUST
   Fasten and secure leg restraint garters and lines. Check leg garters buckled and properly adjusted

with hardware on inboard side of the legs. Check that lines are secured to seat and floor and not twisted. Check that leg restraint lines are routed first through the thigh garter ring, then through the lower garter ring, and then routed outboard of the thigh garter ring before the lock pins are inserted into the seat just outboard of the snubber boxes. Attach parachute risers to harness buckles. Connect and adjust lap belt straps. Connect oxygen, G suit, and communications leads. Check operation of shoulder harness locking mechanism.

WARNING

- The leg restraint lines must be buckled at all times during flight to ensure that the legs will be pulled back upon ejection. This will enhance seat stability and will prevent leg injury by keeping the legs from flailing following ejection.
- Failure to route the restraint lines properly through the garters could cause serious injury during ejection/emergency egress.

2. Oxygen - ON AND CHECK FLOW

Left console -

1. Canopy jettison handle - OUTBOARD AND DOWN
2. Volume control panel - SET
3. Throttles - OFF

Instrument panel -

1. Emergency landing gear handle - IN
2. Emergency brake handle - IN
3. DDI - OFF
4. Comm 1 and 2 knobs - OFF
5. Clock - CHECK AND SET
6. Attitude reference indicator - UNCAGE

Right console -

1. Interior lights - AS DESIRED

BEFORE TAXI

1. DDI - ON
2. Fuel quantity gage - CHECK QUANTITY
3. Altimeter - SET
4. Flight controls - CYCLE
   After FCS reset in the front cockpit, cycle the flight controls.

BEFORE TAKEOFF

1. MENU checklist - CONFIRM COMPLETE

DESCENT/PENETRATION

1. Altimeter setting - CHECK
2. Standby instruments - CHECK

APPROACH

1. Landing checklist - CONFIRM COMPLETE

AFTER LANDING

When clear of active runway -

1. Ejection seat - SAFE
2. DDI - OFF
3. Comm 1 and 2 - OFF
4. Interior lights - OFF
5. Oxygen switch - OFF

NIGHT FLYING

EXTERNAL LIGHT MANAGEMENT

During night operations, the external lights should be set as follows:

1. On the line - Position and formation lights BRT; strobe light OFF
2. When ready to taxi - strobe light ON; taxi light - AS DESIRED
3. Inflight - AS REQUIRED
   a. Single airplane - BRT (or as weather conditions dictate)
   b. Formations - AS REQUIRED BY WINGMAN
      The last aircraft in formation should have external lights on BRT unless tactical situation demands otherwise (actual penetrations).

PART 3 – CARRIER-BASED PROCEDURES

GENERAL

The CV and LSO NATOPS Manuals are the governing publications for the carrier-based operations and procedures.

All flight crewmembers shall be familiar with CV NATOPS procedures and Aircraft Launch/Recovery Bulletins prior to carrier operations.

DAY OPERATIONS

PREFLIGHT

When directed to man the aircraft, conduct a normal preflight inspection with particular attention given to the landing gear, struts, tires, arresting hook, and underside of the fuselage for possible arresting cable damage. Ensure sufficient clearance exists for cycling ALL control surfaces. Interior checks are the same as shore based except anti skid OFF. Note the relationship of the APU exhaust port and the arresting hook to the deck edge. Do not start the APU if there is a possibility of damage from the APU exhaust. Do not lower the hook during post start checks unless the hook point will drop on the flight deck.

CAUTION

The maximum wind allowed for canopy opening is 60 knots. Attempting canopy opening in headwinds of more than 60 knots or in gusty or variable wind conditions may result in damage to or loss of the Canopy.

ENGINE START

When directed, start engines. APU starts should be made whenever possible. Crossbleed starts must be approved by the Air Boss due to the relatively high power setting required, and the potential for injury from the jet blast.

Perform the before taxi checks and be ready to taxi when directed.

TAXI

WARNING

Ensure anti-skid switch is OFF for all carrier operations.

Taxiing aboard ship is much the same as ashore, but increased awareness of jet exhaust, and aircraft directors are mandatory.

Nosewheel steering is excellent for directional control aboard ship. Taxi speed should be kept under control at all times, especially on wet decks, in the landing area, and approaching the catapult. The canopy should be down, O_2 mask on, and the ejection seat armed during taxi. Be prepared to use the emergency brake should normal braking fail. In the event of loss of brakes, inform the tower and lower the tailhook immediately to indicate brake loss to the deck personnel.

HANGAR DECK OPERATION

Occassionally the aircraft will be manned on the hangar deck. Follow the same procedures as those concerning flight deck operation.

Tiedowns shall not be removed from the airplane unless emergency brake accumulator pressure gage indicates at least 2600 psi. The emergency brake shall be used for stopping the airplane anytime it is being moved while the engines are not running. If the aircraft is not already on the elevator, it will be towed or pushed (with the pilot in the cockpit) into position to be raised to the flight deck. Close the canopy, ensure tiedowns are in place, and put the parking brake on anytime the aircraft is on the elevator.

The signal to stop an aircraft that is being towed is either a hand signal or a whistle blast. The whistle signifies an immediate or emergency stop. Leave the canopy open and helmet off to ensure hearing the whistle; keep the plane director in sight at all times. If unable to see the plane director, or if in doubt of safe aircraft movement, stop the aircraft immediately.

BEFORE CATAPULT HOOK-UP

Before taxi onto the catapult, complete the takeoff checklist, set the attitude reference indicator for use if the HUD fails during the launch. The takeoff trim button should be pressed until you see the TRIM advisory and then the horizontal stabilator trim should be manually positioned for the gross weight, flap position and power setting for launch.

CATAPULT HOOK-UP

Before taxiing past the shuttle, airplane gross weight should be verified, takeoff checklist complete, and arming completed by the ordnance crew if required. Check external fuel quantity. Approach the catapult track slowly, lightly riding the brakes, with nosewheel steering on. Use minimum power required to keep the airplane rolling. Close attention to the plane director's signals is required to align the airplane with the catapult track entry wye. When aligned, the plane director will signal the pilot to lower the launch bar. Place the launch bar switch to EXTEND. The green LAUNCH BAR advisory light wil come on and nosewheel steering will disengage. Nosewheel steering low mode may be engaged while the launch bar is down by pressing and holding the nosewheel steering button. This should only be done on signal from the director since catapult personnel may be close proximity to the launch bar. Do not use nosewheel steering once the launch bar enters the track. The catapult crew will install the holdback bar. Taxi forward slowly, following the signals of the plane director. When the launch bar drops over the shuttle spreader, the airplane will be stopped by the holdback bar engaging the catapult buffer. On airplanes thru 161715, upon receipt of the "Release Brakes" signal, advance throttles to 85–90% rpm. Do not advance throttles to MIL at this time since this could retract the launch bar before it is trapped by the tensioned shuttle spreader. On airplanes 161716 and up, upon receipt of the "Release Brakes" signal, advance throtles to MIL.

CATAPULT LAUNCH

WARNING

Do not catapult with partially full external fuel tank(s).

When the "Final Turnup" signal is received from the catapult officer, advance throttles to MIL or MAX. On airplanes thru 161715, the launch bar switch will automatically return to RETRACT and the green LAUNCH BAR advisory light will go out. On airplanes 161716 and up, place the launch bar switch to RETRACT. Check engine instruments and ensure all warning/caution lights are off. If afterburner is to be used, select them on signal from the catapult officer. Cycle the flight controls and when satisfied that the airplane is ready for launch hold throttles firmly against detent, place your head against the head-rest and salute with your right hand. Normally, a 3 to 5 second delay will occur before the catapult fires. Immediately after the end of the catapult stroke, the aircraft will rotate to the desired attitude (approximately 12° nose up) without control stick input if the proper trim is selected; however, the pilot should closely monitor the launch sequence and be prepared to make corrections as necessary. Avoid erratic or unnecessary control movement immediately after launch as pilot-induced-oscillations (PIO) may result. Clearing turns should not be attempted until sufficient flying speed has been attained. Retract the gear and flaps when a positive climb is established.

CATAPULT SUSPEND

If you want to stop the launch while tensioned on the catapult, signal by shaking the head negatively and transmitting "SUSPEND, SUSPEND" on land/launch frequency. Do not use a thumbs down signal or any hand signal that might be mistaken for a salute. The catapult officer will reply with a "SUSPEND" signal followed by an "UNTENSION AIRPLANE ON CATAPULT" signal. The shuttle spreader will be moved aft and the launch bar will automatically raise clear of the shuttle spreader. Maintain power at MIL/MAX until the catapult officer steps in front of the airplane and signals "THROTTLE BACK". The same signals will be used when a catapult malfunction exists.

LANDING PATTERN

Refer to Section 1, Part 4, for carrier operating limitations.

While maneuvering to enter the traffic pattern, attempt to determine the sea state. This information will be of value in predicting problems that may be encountered during the approach and landing.

Enter the carrier landing pattern (figure 3–3) with the hook down. Make a level break from a course parallel to the Base Recovery Course (BRC), close aboard to the starboard of the ship. Below 250 knots lower the gear and flaps. Descend to 600 feet when established downwind and prior to the 180 degree position. Complete the landing checklist and crosscheck angle-of-attack and proper airspeed.

With a 30–knot wind over the deck begin the 180 degree turn to the final approach when approximately abeam the LSO platform. When the meatball is acquired, transmit "Call sign, Hornet, Ball or CLARA, fuel state (nearest 100 pounds) and auto" (if using ATC for approach). Refer to figure 3–4 for a typical Carrier Controlled Approach.

ATC APPROACH MODE TECHNIQUE

The technique required for an ATC approach mode differs from a manual approach in that all glide slope corrections are made by changing airplane attitude. Since this technique violates the basic rule that altitude/glide slope is primarily controlled by the throttle, practice is required to use ATC. For the ATC to perform satisfactorily, smooth attitude control is essential. Large attitude changes will result in divergent glideslope oscillations or overcontrolling power response. Close–in corrections are very critical. If large attitude correction for a high–in–close situation develops, the recommended procedures is to stop ball motion and do not attempt to recenter it. A low–in–close condition is difficult to correct with ATC and usually results in an over–the–top bolter. It may be necessary to manually override ATC in order to safely recover from a low–in–close condition. Throughout the approach the pilot should keep his hand on the throttles in the event it is necessary to manually disconnect/override the ATC.

Carrier Landing Pattern

TYPICAL

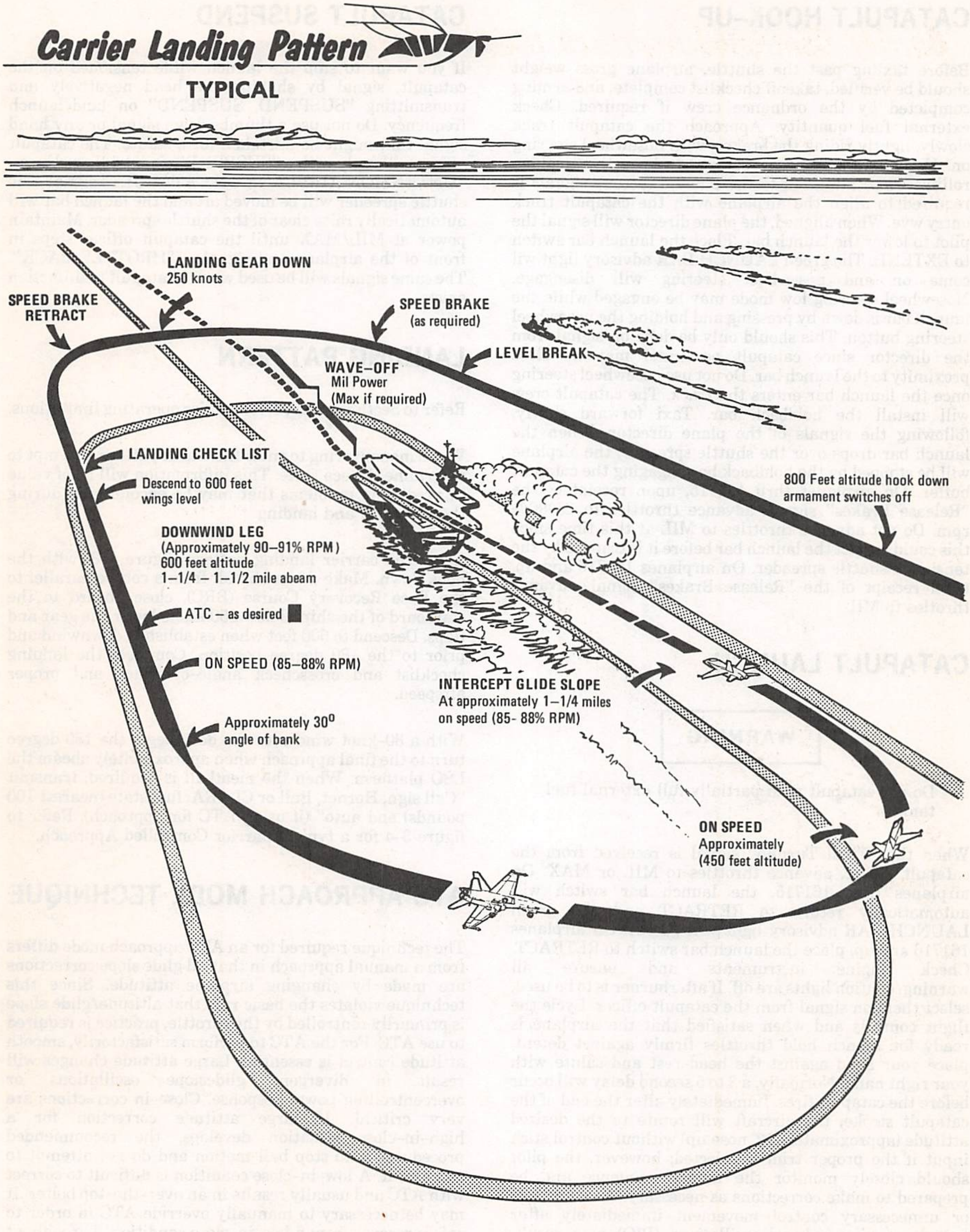

Figure 3-3. Carrier Landing Pattern

Carrier Controlled Approach (CCA)

TYPICAL

VOICE REPORTS

- ENTERING HOLDING
- DEPARTING MARSHAL
- 5000 feet – SIDE NUMBER, PLATFORM
- 10 miles – SIDE NUMBER, 10 MILES
- Acquisition – SIDE NUMBER, HORNET, BALL OR CLARA, FUEL STATE. AUTOBALL (only if ATC)

* Non–precision (ASR) approach only. For precision (PAR) approach, maintain 1200 feet until directed to commence descent.

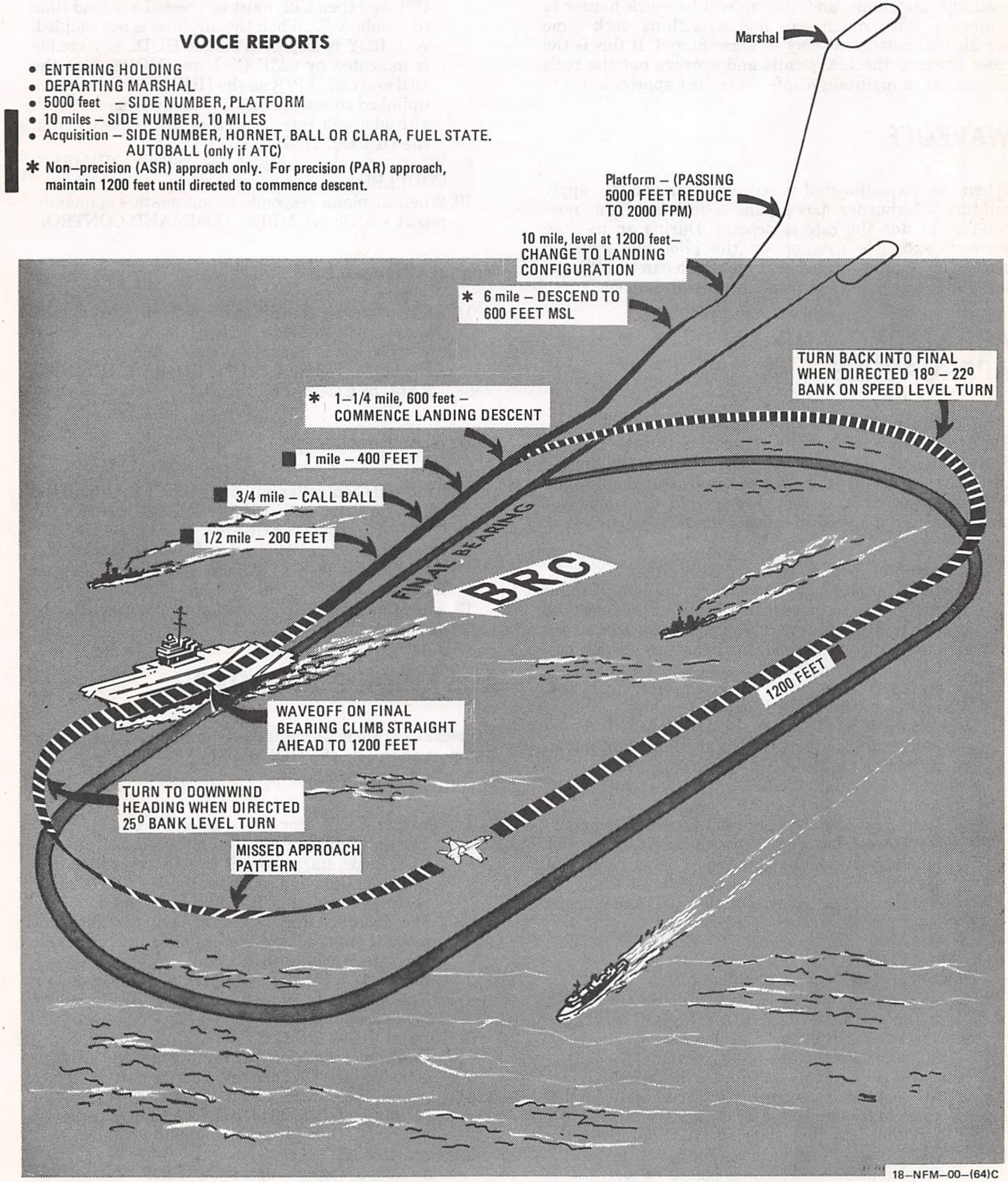
Marshal
Platform – (PASSING 5000 FEET REDUCE TO 2000 FPM)
10 mile, level at 1200 feet– CHANGE TO LANDING CONFIGURATION
* 6 mile – DESCEND TO 600 FEET MSL
TURN BACK INTO FINAL WHEN DIRECTED 18° – 22° BANK ON SPEED LEVEL TURN
* 1–1/4 mile, 600 feet – COMMENCE LANDING DESCENT
■ 1 mile – 400 FEET
■ 3/4 mile – CALL BALL
■ 1/2 mile – 200 FEET
FINAL BEARING
BRC
1200 FEET
WAVEOFF ON FINAL BEARING CLIMB STRAIGHT AHEAD TO 1200 FEET
TURN TO DOWNWIND HEADING WHEN DIRECTED 25° BANK LEVEL TURN
MISSED APPROACH PATTERN
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Figure 3-4. Carrier Controlled Approach (CCA)

GLIDESLOPE

The technique for flying the glideslope is basically the same as FCLP except that more power may be required to maintain glideslope, and line–up will be much harder to maintain. With rough seas and a pitching deck some erratic ball movement may be encountered. If this is the case, listen to the LSO's calls and average out the balls movement to maintain a safe controlled approach.

WAVEOFF

When the waveoff signal is received, immediately apply military/afterburner power and effect a slight nose rotation to stop the rate of descent. During an in–close waveoff, excessive rotation by the pilot will cause a cocked–up or over–rotated attitude which can result in an inflight engagement and possible aircraft damage.

ACL MODE 1 AND 1A APPROACHES

A typical Mode 1 and 1A approach is shown in figure 3–5. The Mode 1 approach requires automatic throttle control. The Mode 1A approach does not require automatic throttle control but it should be used, if available. The following procedure is for a typical Mode 1 and 1A approach from marshal to touchdown or ½ mile.

1. Horizontal indicator (HI) – PRESS ACL
   The Link 4 display appears on the left DDI and ACL mode automatically starts its self test. At this time, the ILS, data link, and radar beacon are automatically turned on (if not previously on); IBIT is run on the data link and radar beacon systems. Also, the uplinked universal test message is monitored for valid receipt.
2. On board ACL capability – CHECK ACL 1
   ACL 1 must be displayed on the Link 4 display to accomplish a Mode 1 or 1A approach.
3. Report departing marshal
4. Normal CCA – PERFORM
   Descend at 4000 feet per minute and 250 knots to 5000 feet, (platform) then reduce rate of descent to 2000 feet per minute. When passing through approximately 5000 feet, ILS steering is automatically displayed on the HUD and must be manually deselected, if not desired.
   a. At 5000 feet, report – SIDE NUMBER, PLATFORM
   b. Continue descent to 1200 feet MSL.
   c. At 10 miles, report – SIDE NUMBER, 10 MILES
5. Landing checklist – COMPLETE AT 10 MILES
   a. Slow to approach speed at 6 miles.
6. Automatic throttle control – ENGAGE
7. Radar altitude hold – ENGAGE (if desired)
   ACL acquisition occurs at approximately 3.5 to 5 miles and is indicated by ACL RDY on the DDI and the data link steering (TADPOLE) on the HUD. It is desired, but not required, to have ACL coupled at least 30 seconds before tipover. T/C is replaced by MODE 1 on the link 4 display.

After ACL Acquisition –

8. On the upfront control, CPL button – PRESS TWICE
   Traffic control must be decoupled by pressing CPL and then CPL must be pressed a second time to couple ACL. When the airplane is not coupled, ACL RDY is displayed on the HUD. ACL couple is indicated by CMD CNT and MODE 1 on the DDI and CPLD P/R on the HUD. At this time, the uplinked command displays of heading, airpseed, altitude, and rate of descent are removed from the DDI and HUD.
9. When coupled, report – SIDE NUMBER, COUPLED
10. When airplane responds to automatic commands, report – SIDE NUMBER, COMMAND CONTROL

Mode 1A Approach –

11. At ½ mile, the controller or pilot may downgrade the approach to Mode 2. Continue manually with the approach and make a visual landing.
    a. Uncouple, report – SIDE NUMBER, HORNET, BALL or CLARA, FUEL STATE.

Mode 1 Approach –

11. At ½ mile controller will advise the pilot to call the ball. Report – SIDE NUMBER, HORNET, COUPLED, BALL or CLARA, FUEL STATE.
12. At approximately 12.5 seconds before touchdown, the uplinked 10 SEC is displayed on the DDI and HUD.
13. After touchdown, ACL and automatic throttles are disengaged.

ACL MODE 2 APPROACH

A typical ACL Mode 2 approach is shown in figure 3–6. For a Mode 2 approach, the HUD data link steering is used to fly a manual approach.

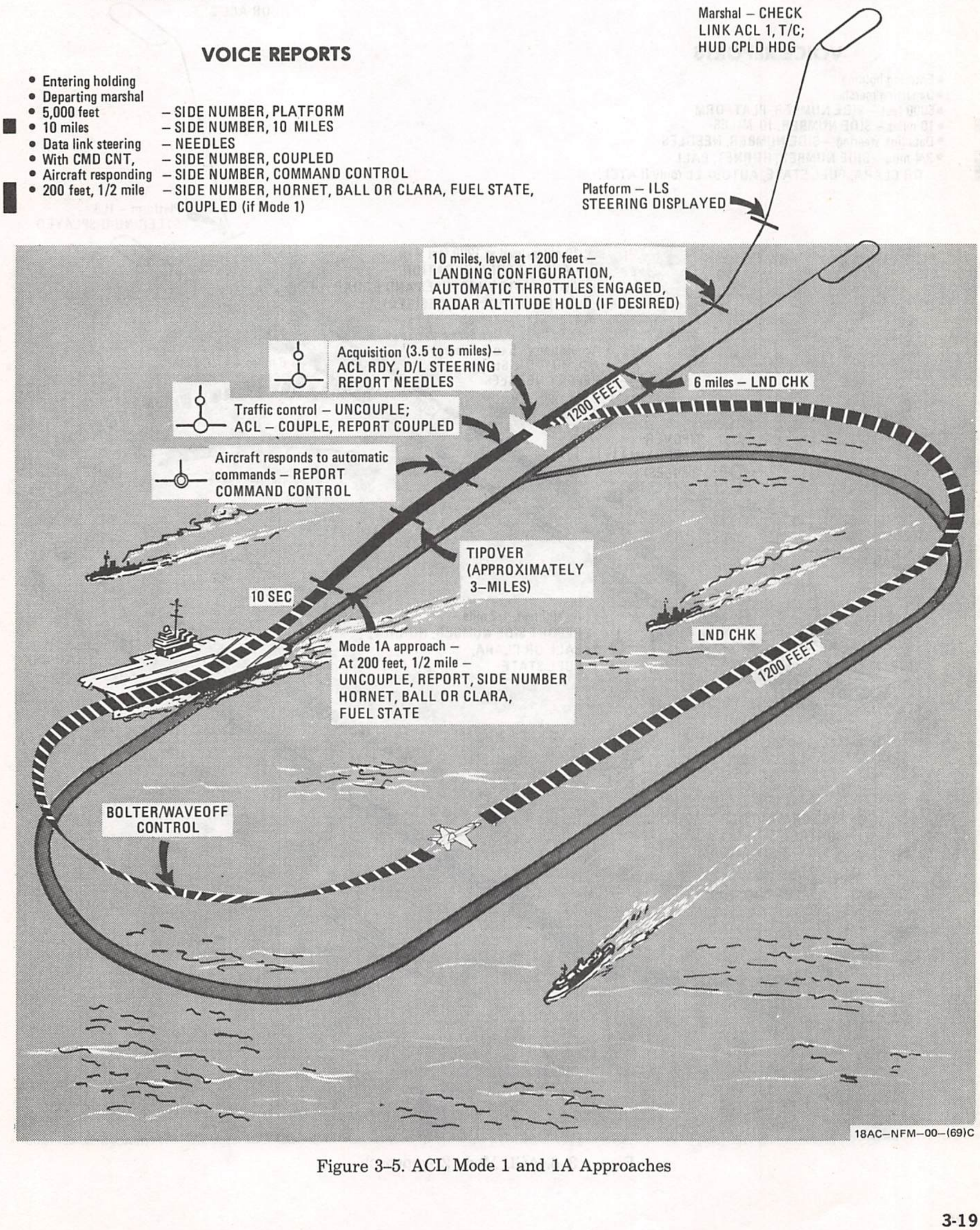
1. Horizontal indicator (HI) – PRESS ACL
   The link 4 display appears on the left DDI and the ACL mode starts its self test. At this time, the ILS, data link, and radar beacon are turned on (if not previously on); IBIT is run on the data link and radar beacon systems. Also, the autopilot mode is engaged and the unlinked universal test message is monitored for valid receipt.
2. Onboard ACL capability – CHECK ACL OR ACL 2
   Either ACL 1 OR ACL 2 may be displayed for Mode 2 approach.
3. Normal CCA – PERFORM
   Descend at 4000 feet per minute and 250 knots to 5000 feet, then reduce rate of descent to 2000 feet per minute. When passing through approximately 5000 feet, ILS steering is displayed on the HUD and must be manually deselected, if not desired.
   a. At 5000 feet, report – SIDE NUMBER, PLATFORM

ACL Mode 1 and 1A Approaches

TYPICAL

VOICE REPORTS

• Entering holding	
• Departing marshal	
• 5,000 feet	– SIDE NUMBER, PLATFORM
• 10 miles	– SIDE NUMBER, 10 MILES
• Data link steering	– NEEDLES
• With CMD CNT,	– SIDE NUMBER, COUPLED
• Aircraft responding	– SIDE NUMBER, COMMAND CONTROL
• 200 feet, 1/2 mile	– SIDE NUMBER, HORNET, BALL OR CLARA, FUEL STATE, COUPLED (if Mode 1)



Marshal – CHECK LINK ACL 1, T/C; HUD CPLD HDG

Platform – ILS STEERING DISPLAYED

10 miles, level at 1200 feet – LANDING CONFIGURATION, AUTOMATIC THROTTLES ENGAGED, RADAR ALTITUDE HOLD (IF DESIRED)

Acquisition (3.5 to 5 miles)– ACL RDY, D/L STEERING REPORT NEEDLES

Traffic control – UNCOUPLE; ACL – COUPLE, REPORT COUPLED

Aircraft responds to automatic commands – REPORT COMMAND CONTROL

6 miles – LND CHK

TIPOVER (APPROXIMATELY 3-MILES)

Mode 1A approach – At 200 feet, 1/2 mile – UNCOUPLE, REPORT, SIDE NUMBER HORNET, BALL OR CLARA, FUEL STATE

BOLTER/WAVEOFF CONTROL

Figure 3-5. ACL Mode 1 and 1A Approaches

ACL Mode 2 Approach

TYPICAL

VOICE REPORTS

- Entering holding
- Departing marshal
- 5000 feet – SIDE NUMBER, PLATFORM
- 10 miles – SIDE NUMBER, 10 MILES
- Data link steering – SIDE NUMBER, NEEDLES
- 3/4 mile – SIDE NUMBER, HORNET, BALL OR CLARA, FUEL STATE, AUTOBALL (only if ATC)

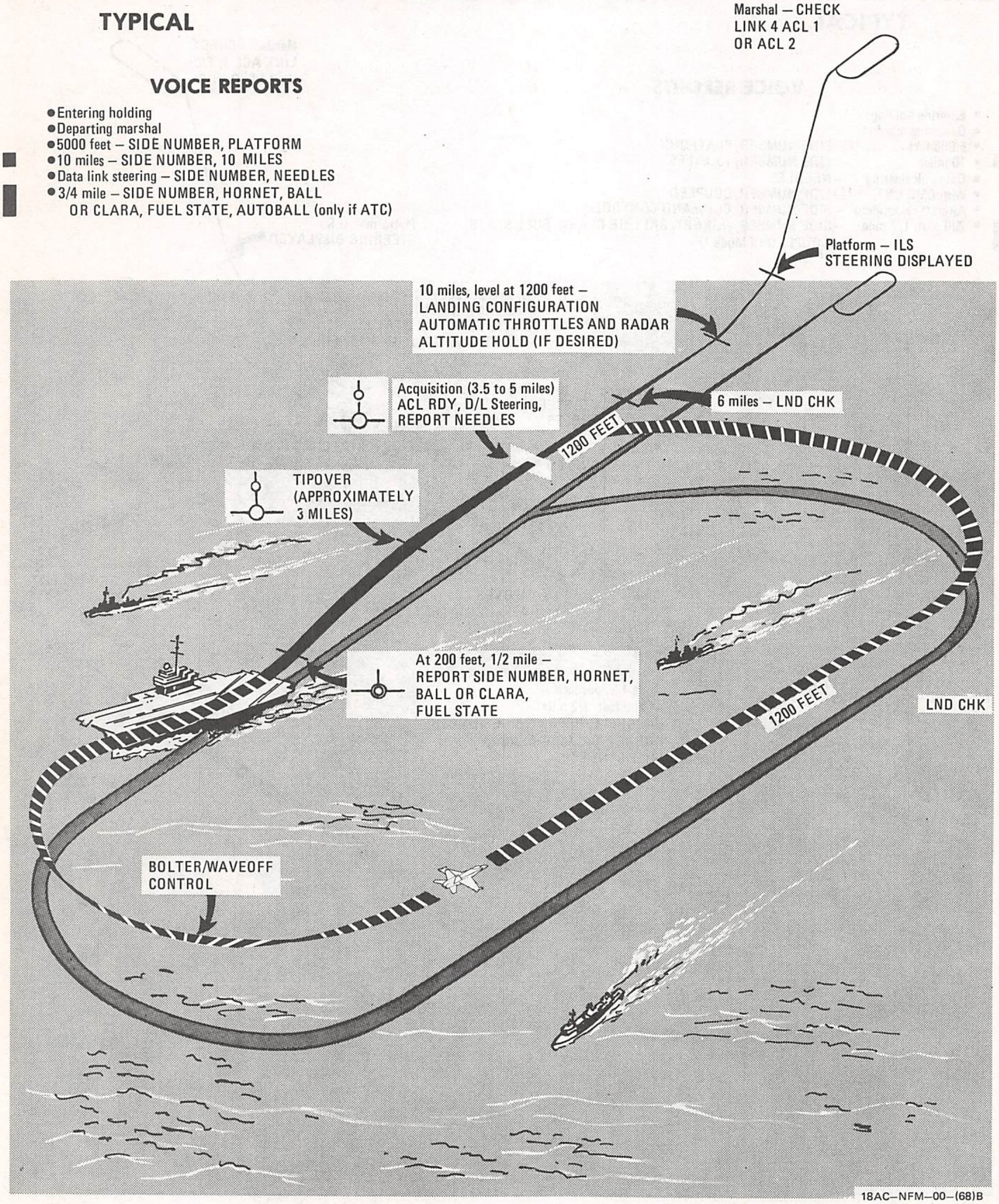


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Figure 3-6. ACL Mode 2 Approach

- b. Continue descent to 1200 feet MSL.
- c. At 10 miles, report - SIDE NUMBER, 10 MILES

4. Landing checklist - COMPLETE AT 10 MILES
   - a. Slow to approach speed at 6 miles.
5. Automatic throttles - ENGAGE (if desired)
6. Radar altitude hold - ENGAGE (if desired)

   ACL Acquisition occurs at approximately 3.5 to 5 miles and is indicated by ACL RDY on the DDI and data link steering (TADPOLE) on the HUD

After acquisition -

7. Report - SIDE NUMBER, NEEDLES
8. Link 4 display - CHECK MODE 1 OR MODE 2
9. At ¾ mile, report - SIDE NUMBER, HORNET, BALL or CLARA, FUEL STATE.

ARRESTED LANDING AND EXIT FROM THE LANDING AREA

Fly the aircraft on the glideslope and ON-SPEED all the way to touchdown. Advance the throttles to MIL as the aircraft touches down. When forward motion has ceased reduce power to IDLE and allow the aircraft to roll aft. Apply brakes on signal. Raise the hook when directed. If the wire does not drop free, drop the hook when directed, and allow the aircraft to be pulled aft. Raise the hook again on signal.

When the come ahead signal is received add power, release brakes, and exit the landing area cautiously and expeditously. Fold the wings unless directed otherwise.

If one or both brakes fail, utilize the emergency brakes, advise the tower and drop the arresting hook. Taxi the aircraft as directed. Do not use excessive power. Once spotted, keep the engines running until the CUT signal is given by the plane director and the minimum required number of chocks or tiedown chains are installed.

NIGHT OPERATIONS

GENERAL

Night carrier operations will have a much slower tempo than daylight operations and it is the pilot's responsibility to maintain this tempo. Standard daytime hand signals from deck crew to pilot will be executed with light wands. The procedures outlined here are different from, or in addition to, normal day carrier operations.

PREFLIGHT

Conduct the exterior preflight using a white lensed flashlight. Ensure that the exterior lights are properly positioned for launch and the external lights master switch OFF before engine start. Ensure that instrument and console light rheostats are on. This will reduce brilliance of the warning and advisory lights when the generators come on.

BEFORE TAXI

Adjust cockpit lighting as desired and perform before taxi checks.

TAXI

Slow and careful handling by aircraft directors and pilots is mandatory. If any doubt exists as to the plane director's signals, stop the aircraft. At night it is very difficult to determine speed or motion over the deck; rely on the plane director's signals and follow them closely.

CATAPULT HOOK-UP

Maneuvering the airplane for catapult hook-up at night is identical to that used in day operations; however, it is difficult to determine your speed or degree of motion over the deck.

CATAPULT LAUNCH

On turnup signal from the catapult officer, ensure throttles are in MIL or MAX and check all instruments. When ready for launch, place external lights master switch ON.

All lights should be on bright with the strobes on. If you expect to encounter instrument meterological conditions shortly after launch, the strobes may be left off at the discretion of the pilot.

After launch monitor rotation of the aircraft to 12° nose up cross checking all instruments to ensure a positive rate of climb. When comfortably climbing, retract the landing gear and flaps and proceed on the departure in accordance with ships' procedures. The attitude reference indicator should be used in the event of a HUD failure.

AIRCRAFT OR CATAPULT MALFUNCTION

If a no-go situation arises, do not turn on the exterior lights and transmit "SUSPEND, SUSPEND". Maintain MIL/MAX power until the catapult officer walks in front of the wing and gives the throttle-back signal. If the external lights master switch has been placed on prior to ascertaining that the aircraft is down, transmit "SUSPEND, SUSPEND" but leave the exterior lights on and the throttle at MIL until signalled to reduce power.

LANDING PATTERN

Night and instrument recoveries will normally be made using case III procedures in accordance with the CV NATOPS Manual.

ARRESTMENT AND EXIT FROM THE LANDING AREA

During the approach all exterior lights should be on with the exception of taxi/landing light and strobes. Following arrestment, immediately turn the external lights master switch off. Taxi clear of the landing area following the plane director's signals.

SECTION CCA

A section CCA may be necessary in the event a failure occurs affecting navigation aids, communications equipment, or other aircraft systems.

Normally, the aircraft experiencing the difficulty will fly the starboard wing position during the approach. The section leader will detach the wingman when the meatball is sighted and continue straight ahead, offsetting as necessary to the left to determine if the wingman lands successfully. Lead shall continue descending to not lower than 300 feet and turn on all lights to bright and strobes on. This will provide the wingman with a visual reference in the event of a bolter or waveoff. The wingman should not detach until the meatball is in sight. If the wingman fails to arrest, the leader will begin a climb to 1200 feet or remain VFR at 150 knots during the rendezvous, but in no case should a rendezvous be attempted below non-precision minimums. The rendezvous should be completed before any turns are made to begin another approach. If the weather is below non-precision minimums, the wingman should expect to climb to VFR–on–top heading for the nearest divert field. The leader will join the wingman as vectored by CATCC. Necessary lighting signals between aircraft are contained in Section VII.

NOTE

A section penetration should not be made to the ship with less than non-precision minimums.

PART 4 - SPECIAL PROCEDURES

FORMATION FLIGHT

FORMATION TAKEOFF

For formation takeoff, all aspects of the takeoff must be prebriefed by the flight leader. This should include flap settings; use of nosewheel steering; power changes; power settings; and signals for actuation of landing gear, flaps, and afterburner. The leader will take position on the downwind side of the runway with other aircraft in tactical order, maintaining normal parade bearing. Refer to figure 3–7. For three aircraft formations, line up with the lead on the downwind side, number 2 on the centerline, and number 3 on the upwind side. Wingtip/launch rail overlap should not be required but is permitted if necessary. For four plane formations, line up with the lead's section on the downwind half of the runway and other section on the upwind half. After Before Takeoff checks are completed and the flight is in position, each pilot looks over the next aircraft to ensure the speed brake is retracted, the flaps are set for takeoff, all panels are closed, no fluids are leaking, safety pins are removed, rudders are toed–in, nosewheel is straight and the launch bar is up. Beginning with the last aircraft in the flight, a "thumb up" is passed toward the lead to indicate "ready for takeoff". Engines are run up to approximately 80%, instruments check, and nosewheel steering low gain ensured. On signal from the leader, brakes are released, throttles are advanced to military power minus 2% rpm. If afterburner is desired, the leader may go into mid range burner immediately without stopping at military power, or may select afterburner during the takeoff roll. Normal takeoff techniques should be used by the leader, with the wingman striving to match the lead airplanes attitude as well as maintain a position in parade bearing with wingtip separation. The gear and flaps are retracted on signal. Turns into the wingman will not be made at altitudes less than 500 feet above ground level. The first section must be airborne before the second section commences its takeoff roll.

ABORTED TAKEOFF

In the event of an aborted takeoff, the airplane aborting must immediately notify the other airplane. The airplane not aborting should add max power and accelerate ahead and out of the way of the aborting airplane. This allows the aborting airplane to steer to the center of the runway and engage the arresting gear, if required.

PARADE

The parade position is established by aligning the bottom wingtip light (located about in the middle of the missile rail) with the light on the LEX. Superimposing the two establishes a bearing line and step down. Proper wingtip clearance is set by reference to the exhaust nozzles. When the left and right nozzles are aligned so that there is no detectable curved to the nozzles, then the reference line is correct. The intersection of the reference line with the bearing line is the proper parade position. Refer to figure 3–8.

Parade turns are either standard (VFR) or instrument turns. During day VFR conditions, turns away from the wingman are standard turns. To execute, when lead turns away the wingman roll their aircraft about their own axis and increase power slightly to maintain rate of turn with the leader. Lateral separation is maintained by increasing G. Proper step down is maintained by keeping the leads fuselage on the horizon.

Turns into the wingmen and all IFR or night turns in a parade formation are instrument turns. During instrument turns maintain a parade position relative to the lead throughout the turn.

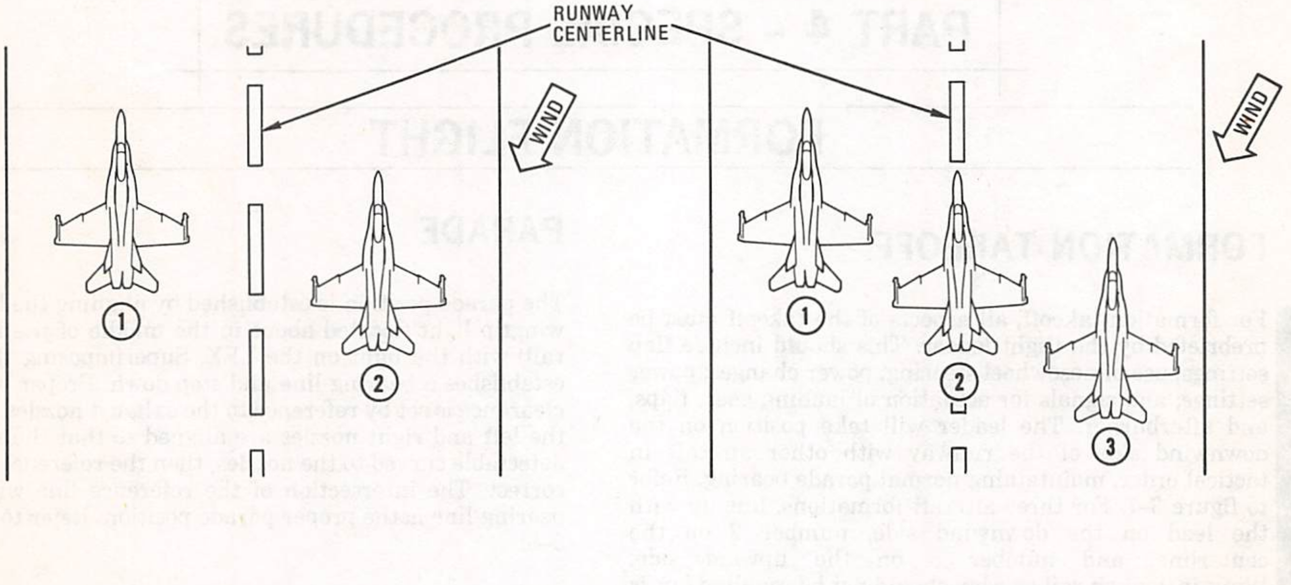
After initially joining up in echelon, three and four plane formations normally use balanced parade formation. In balanced parade number 3 will step out until the exhaust nozzles on number 2 are flush. This leaves enough space between number 3 and lead for number 2 to cross under into echelon.

When it is necessary to enter IFR conditions with a three or four plane formation, the lead directs the flight to assume fingertip formation. In this formation number 3 moves up into close parade on the lead. All turns are instrument turns.

CRUISE FORMATION

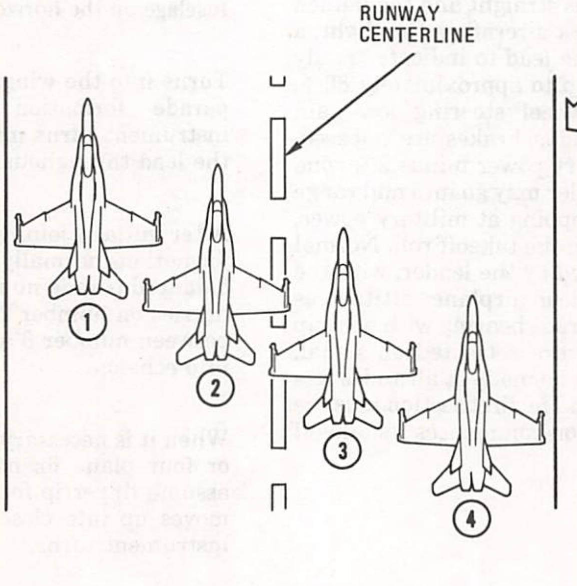
The cruise position is a looser formation which allows the wingmen more time for visual lookout. Cruise provides the wingmen with a cone of maneuver behind the leader which allows the wingman to make turns by pulling inside the leader and requires little throttle change.

Formation Takeoff Runway Alignments



2 PLANE FORMATION

3 PLANE FORMATION



4 PLANE FORMATION

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Figure 3–7. Formation Takeoff Runway Alignments

Formations

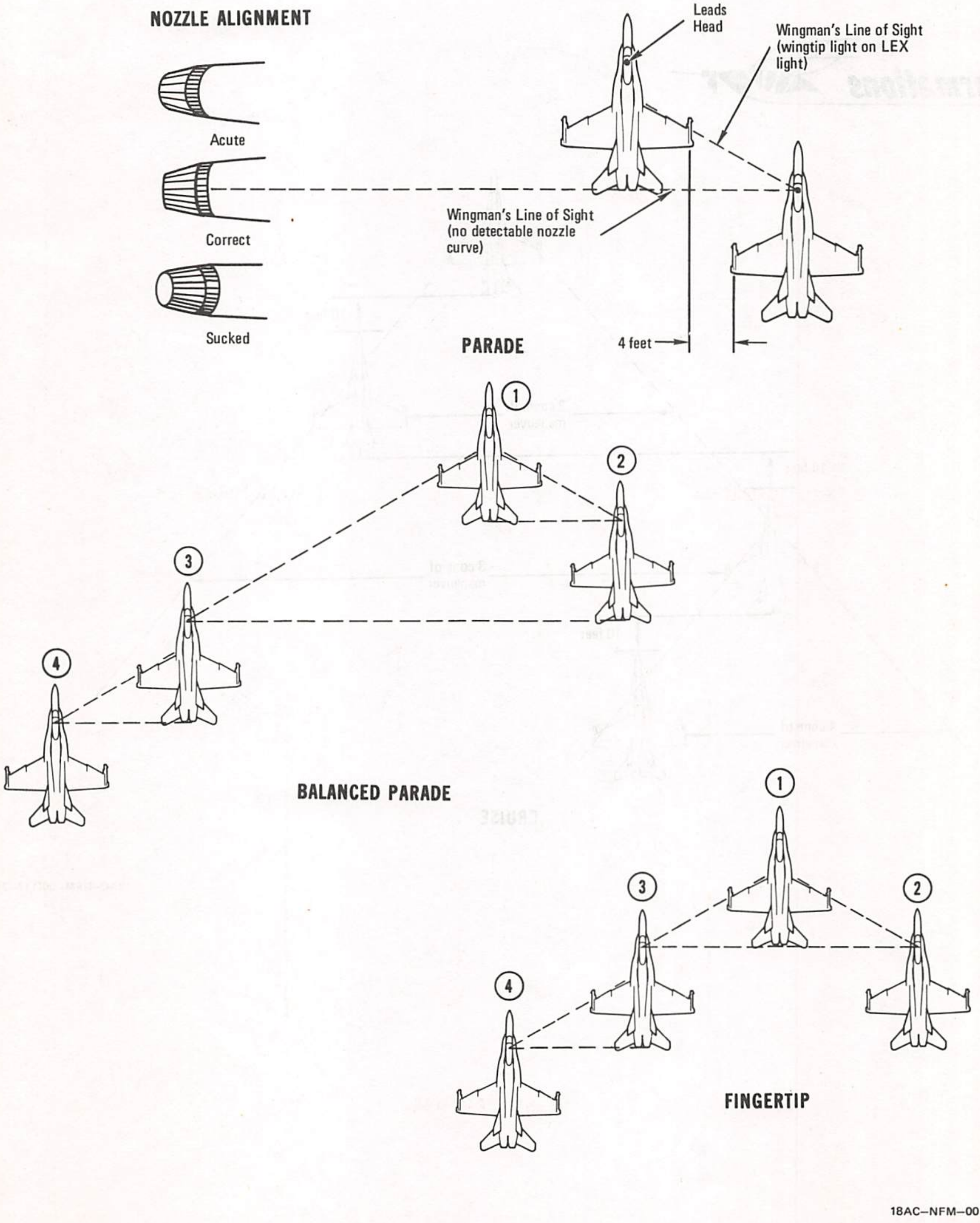
NOZZLE ALIGNMENT
Acute
Correct
Sucked
Leads Head
Wingman's Line of Sight (wingtip light on LEX light)
Wingman's Line of Sight (no detectable nozzle curve)
4 feet
PARADE
①
②
③
④
BALANCED PARADE
①
③
②
④
FINGERTIP

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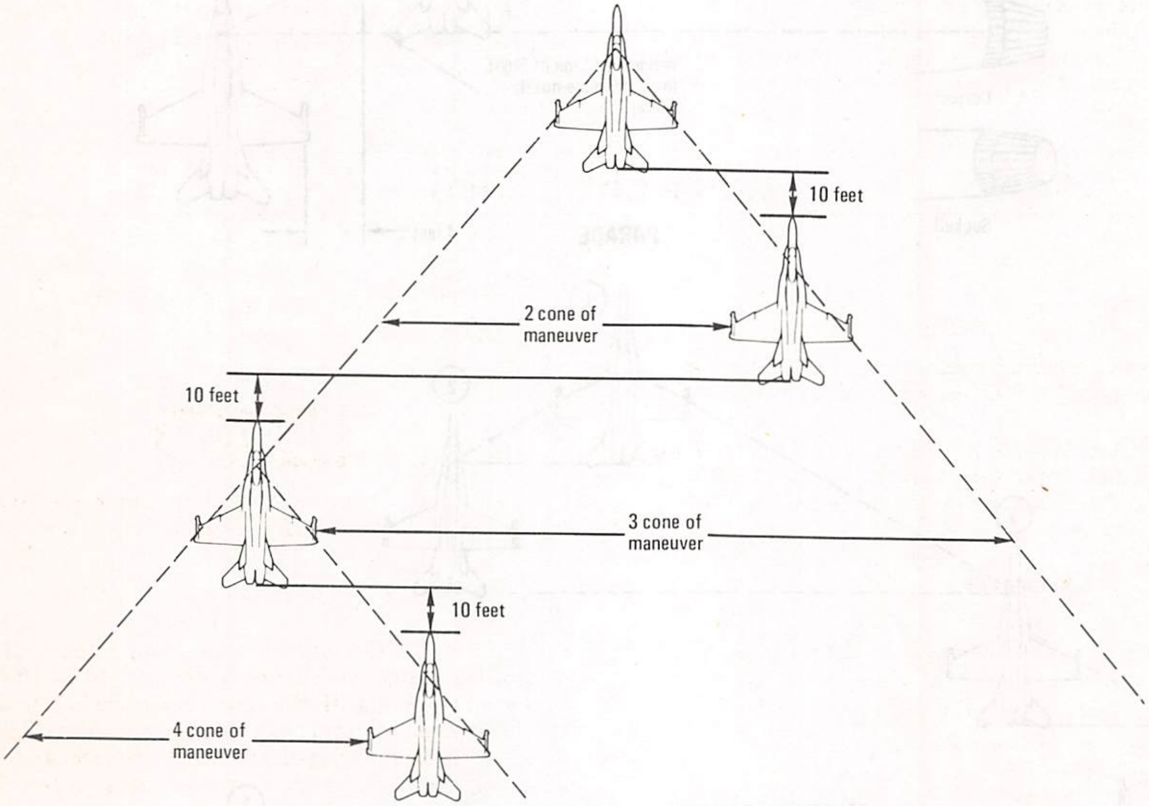
Figure 3-8. Formations (Sheet 1 of 2)

Formations



CRUISE

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Figure 3-8. Formations (Sheet 2)

The cruise position is defined by a line from the lead pilot's head, through the trailing edge of the wingtip missile rail, with 10 feet of nose to tail separation. The wingmen are free to maneuver within the 70° cone established by that bearing line on either wing. In a division formation, number 3 should fly the bearing line, but always leave adequate room for number 2 aircraft and lead. Number 4 flies cruise about number 3.

SECTON APPROACHES

The aircraft is comfortable to fly in formation, even at the low airspeeds associated with an approach and landing. The rapid power response enhances position keeping ability. The formation strip lighting provides a ready visual reference at night and the dual radios generally ensure that intra-flight comm is available.

During section approaches all turns are "instrument" turns about the leader. When a penetration is commenced the leader retards power to 75% rpm and descends at 250 knots. If a greater descent rate is required the speed brake may be used. Approximately 5 miles from the final approach fix or GCA pickup the lead gives the signal for landing gear.

To execute a section missed approach, the lead advances the throttles to arrest sink rate and rotates the nose to commence a climb. The velocity vector should be established 3 to 5° above the horizon. Once a positive rate of climb is established lead gives the landing gear signal and both aircraft raise the gear and flaps.

AIR REFUELING

NOTE

Before air refueling operations, you must be familiar with NATOPS Air Refueling Manual.

The KA-3, KA-6, KC-10, KC-130, and A-6 and A-7 with D-704 or 31-300 buddy stores are authorized tankers for air refueling. Maximum refueling pressure is 55 psi.

BEFORE PLUG-IN

Complete the air refueling checklist before plug in.

1. Radar - STBY/SILENT/EMCOM
2. Master arm switch - SAFE
3. Fuel dump - OFF
4. Internal wing fuel switch - AS DESIRED
5. External tanks - AS DESIRED
6. Air refuel probe switch - EXTEND
7. Visor recommended down

For night air refueling -

8. Exterior lights - STEADY BRIGHT
9. Tanker lights - AS DESIRED

REFUELING TECHNIQUE

NOTE

The following procedures, as applied to tanker operation, refer to single drogue refuelers.

Refueling altitudes and airspeeds are dictated by receiver and/or tanker characteristics and operational needs, consistent with the tanker's performance and refueling capabilities. This, generally, covers a practical spectrum from the deck to 40,000 feet and 175 to 300 knots while engaged.

APPROACH

CAUTION

Be careful to avoid damaging the right AOA probe by contact with basket or hose.

Once cleared to commence an approach, refueling checklists completed, assume a position 10 to 15 feet in trail of the drogue with the refueling probe in line in both the horizontal and vertical reference planes. Trim the airplane in this stablized approach position and insure that the tanker's (amber) ready light is on before attempting an approach. Select a reference point on the tanker as a primary alignment guide during the approach phase; secondarily, rely on peripheral vision of the drogue and hose. Increase power to establish 3 to 5 knots closure rate on the drogue (6 knots maximum). An excessive closure rate will cause a violent hose whip following contact and/or increase the danger of structural damage to the airplane in the event of misalignment; whereas, too slow a closure rate results in the pilot fencing with the drogue as it oscillates in close proximity to the airplanes nose. During the final phase of the approach, the drogue has a tendency to move slightly upward and to the right as it passes the nose of the receiver airplane due to the airplane-drogue airstream interaction. Small corrections in the approach phase are acceptable; however, if alignment is off in the final phase, it is best to immediately retire to the initial approach position and commence another approach, compensating for previous misalignment by adjusting the reference point selected on the tanker. Make small lateral corrections with the rudder, and vertical corrections with the stabilator. Avoid any corrections about the longitudinal axis since they cause probe displacement in both the lateral and vertical reference planes.

MISSED APPROACH

If the receiver probe passes forward of the drogue basket without making contact, initiate a missed approach immediately. If the probe impinges on the rim of the basket and tips it, initiate a missed approach. A missed approach is executed by reducing power and backing to the rear at a 3 to 5 knot opening rate. By continuing an approach past the basket, a pilot might hook the probe over the hose and/or permit the drogue to contact the receiver airplane fuselage. Either of these hazards require more skill to calmly unravel the hose and drogue without causing further damage than to make another approach. If the initial approach position is well in line with the drogue, the chance of hooking the hose is diminished when last minute corrections are kept to a minimum. After executing a missed approach, analyze previous misalignment problems and apply positive corrections to avoid a hazardous tendency to blindly stab at the drogue.

CONTACT

When the receiver probe engages the basket, it will seat itself into the drogue coupling and a slight ripple will be evident in the refueling hose. The tanker's drogue and hose must be pushed forward 3 to 5 feet by the receiver probe before fuel transfer can be effected. This position is evident by the tanker's (amber) ready light going out and the (green) fuel transfer light coming on. While plugged-in, fly a close tail chase formation on the tanker. Although this tucked-in condition restricts the tanker's maneuverability, gradual changes involving heading, altitude and/or airspeed may be made. A sharp lookout doctrine must be maintained due to the precise flying imposed on both the tanker and receiver pilots. In this respect, the tanker can be assisted by other aircraft in the formation.

DISENGAGEMENT

Disengagement from a successful contact is accomplished by reducing power and backing out at a 3 to 5-knot separation rate. Maintain the same relative alignment on the tanker as upon engagement. The receiver probe will separate from the drogue coupling when the hose reaches full extension. When clear of the drogue, place the refueling probe switch in the RETRACT position. Ensure that the PROBE UNLK caution display is out before resuming normal flight operations.

SHORT AIRFIELD FOR TACTICAL SUPPORT (SATS) PROCEDURES

LANDING PATTERN

Approach the break point either individually or in echelon, parade formation, at 250 knots. A 17 to 20 second break interval will provide a 35 to 40 second touchdown interval. Have the landing checklist completed, be at on-speed AOA/approach speed by the 180° position.

APPROACH

Plan for and execute an on-speed approach. Pay particular attention to maintaining the proper airspeed and correct lineup.

WAVEOFF

To execute a waveoff, immediately add full power, and maintain optimum attitude. Make all waveoffs straight ahead until clear of the landing area.

ARRESTED LANDING

The airplane should be on runway centerline at touchdown. Airplane alignment should be straight down the runway with no drift. Upon touchdown, maintain the throttle at the approach position. When arrestment is assured, retard the throttle to idle. Allow the airplane to roll back to permit the hook to disengage from the pendant. When directed by the taxi director, apply both brakes to stop the rollback and raise the hook. If further rollback is directed, release brakes and allow the airplane to be pulled back until a brake signal is given. Then apply brakes judiciously to prevent the airplane from tipping or rocking back.

CAUTION

Use extreme caution when taxiing on a wet SATS runway.

BOLTER

Bolters are easily accomplished. Simultaneously apply full power and retract the arresting gear hook. Smoothly rotate the aircraft to a liftoff attitude and fly away.

WARNING

If landing on a runway with a SATS catapult installed, care must be taken to prevent engagement of the dolly arrester ropes with the airplane tailhook. Structural damage to the airplane and catapult will result.

PART 5 – FUNCTIONAL CHECKFLIGHT PROCEDURES

GENERAL

Requirements for functional checkflight are listed in OPNAVINST 4790.2 Series and will be performed using the applicable Functional Checkflight Checklist. This section contains a detailed description of the checkflight requirements, sequenced in the order in which they will be performed. The checkflight personnel will familiarize themselves with these requirements prior to the flight. The FCF requirements do not replace normal procedures in part 2, NATOPS procedures will apply during the entire checkflight. Only those pilots designated in writing by the Squadron Commanding Officer shall perform squadron checkflights. Checkflight procedures will be in accordance with the current edition of OPNAVINST 4790.2. Items contained in the Functional Checkflight Requirements are coded. This coding is intended to assist the FCF pilot in determining which items pertain to the various conditions requiring checkflights. Items coded (B) pertain to engine/fuel control maintenance as outlined in OPNAVINST 4790.2. Items coded (C) pertain to flight control/rigging maintenance as outlined in OPNAVINST 4790.2. Items coded (A) constitute a complete Functional Checkflight, requirements for which are outlined in OPNAVINST 4790.2. Coding shall appear adjacent to a step.

CHECKFLIGHT REQUIREMENTS F/A–18A (TF/A–18A FRONT COCKPIT)

PREFLIGHT

1. (A) Exterior inspection – PERFORM
   Perform an exterior inspection in accordance with Part 2, this section. Particular attention shall be made to check for loose or improperly installed panels in those areas where maintenance has been performed.
2. (A) Interior check – PERFORM
   Perform an interior check in accordance with Part 2, this section.
3. (A) External electrical power – APPLY
   Place external power switch to RESET and check for proper electrical power on the airplane.
4. (A) Avionics ground cooling fan – CHECK OPERATION
5. (A) Intercom – ESTABLISH
6. (A) Fuel quantity BIT – PERFORM
7. (A) Pitot heat – CHECK
   Place the pitot heater switch to ON and have ground crew verify both pitot heads get warm. Limit pitot heat operation to a maximum of 1 minute. Return switch to AUTO.
8. (A) Oxygen – ON AND CHECK
   A minimum of 4 liters is required. Press and hold the oxygen test button and ensure the OXY LOW caution is displayed within 2 seconds of the oxygen gage needle reaching 1 liter. Release button and check that needle returns to original quantity and OXY LOW display is removed.
9. (A) Warning and caution lights – TEST
10. (A) Fire detection system – CHECK AND TEST
    After fire test A and B, rotate the bleed air knob to OFF and back to NORM. Voice alert system should be activated.
11. (A) Interior and exterior lights – CHECK
12. (A) Seat – ADJUST
    There are no stops on the seat motor. Do not hold the seat switch with the seat full up or down.
13. (A) DDI and HI – ON

ENGINE START

1. (A) Engine start – PERFORM
   Perform engine start in accordance with Part 2, this section.
2. (AC) Stabilator feedback linkage – CHECK
3. (A) Right engine – CHECK
4. (A) Left engine – CHECK
5. (A) Hydraulic pressure – CHECK
   Check that HYD1 and HYD2 pressure is 2850 to 3250 psi.

BEFORE TAXI

1. (A) Before taxi procedures – PERFORM
   Perform before taxi procedures in accordance with Part 2, this section.
2. (AB) Generators – CHECK (complete test within 7 seconds)
3. (AB) Bleed air control – CHECK
   With engines at IDLE, select L OFF and R OFF

individually, the opposite engine EGT will increase 5 to 90°C. Return bleed air knob to NORM. Momentarily place fire and bleed air test switch to TEST A. Check that the L and R BLEED warning lights come on, L and R BLD OFF cautions are displayed, the voice alert is activated, and airflow to cockpit stops. Cycle bleed air knob to OFF and back to NORM. Momentarily place fire and bleed air test switch to TEST B. Check that the L and R BLEED warning lights come on, L and R BLD OFF cautions are displayed, the voice alert is activated, and airflow to cockpit stops. Cycle bleed air knob to OFF and back to NORM.

4. (A) Inertial navigation system - CHECK
   Check waypoint 0 and magnetic variation. QUAL should be "OK" within 6 minutes. Cycle the parking brake and check that alignment time flashes then stops flashing when parking brake is set to ON.
5. (A) Radar - CHECK
   Place radar power knob to OPR. For the first 30 seconds, not ready is displayed. After 30 seconds, TEST is displayed. After 3 minute time-out, transmitter radiates into the dummy load and AIM-7 missile tuning horns for 5 seconds, then automatically shuts down.
6. (AC) Flight controls - CHECK/BIT
   a. Actuator exerciser mode - INITIATE (after 7.0 PROM)
   b. FCS IBIT - INITIATE
7. (AC) Spin recovery mode - CHECK
   a. Flaps - AUTO
   b. Spin recovery switch - RCVY
   c. Check both DDI's - SPIN MODE
   d. Flaps - LEF 34° TEF 0° (after 7.0 PROM)
   e. Spin recovery switch - NORM
8. (AC) Trim - CHECK
   Trim ailerons and rudders full left and stabilator full nose up. Press T/O TRIM button. Check that ailerons and rudders return to neutral, stabilator returns to −4.0 and the T/O TRIM advisory comes on. Repeat check in the opposite direction.
9. (A) Standby altimeter - SET AND CHECK
   Set reported barometric pressure in window. Verify barometric set value on HUD. Verify HUD display reads within ±30 feet and altimeter reads within ±60 feet of ramp elevation.
10. (A) Attitude reference indicator - CHECK
    Check that attitude reference indicator levels.
11. (A) Windshield anti-ice/rain removal - CHECK
    Place the switch to ANTI-ICE, check for high airflow across the windshield. Place the switch to RAIN, check for reduced airflow across the windshield. Place the switch to OFF, check that airflow stops.
12. (A) Defog - CHECK
    Place the defog handle to LOW, check for minimum defog airflow and maximum cabin airflow. Slowly move the defog handle to HIGH and check for progressively less cabin airflow and higher defog flow.
13. (A) Cockpit temperature control - CHECK
    Select OFF/RAM and check that cockpit pressurization air is shut off. Select MAN and rotate temperature control knob between COLD and HOT and check that cockpit temperature changes to agree with temperature setting. Repeat with AUTO selected.
14. (A) Head up display - CHECK
    a. With HUD selector switch in AUTO, rotate the HUD symbology brightness symbology brightness control knob from OFF to the desired contrast.
    b. Place HUD symbology reject switch to REJ 2 and check that heading scale, command heading, heading box, heading caret, altitude box, airspeed box, nav range (if displayed), bank angle scale and bank angle pointer are deleted from the HUD. Place the switch to NORM and check that all symbols return.
    c. Vary the symbology brightness in both the NIGHT and DAY mode then return the HUD symbology rightness selector switch to AUTO.
    d. Place the altitude switch to RDR and check that the HUD is displaying radar altitude (if radar altimeter is on). Return the switch to BARO and check that barometric altitude is displayed.
    e. Place the attitude selector switch to STBY, check that the velocity vector disappears and pitch ladder is referenced to miniature aircraft symbol (W). Return the switch to AUTO.
15. (A) Canopy - CHECK
    Place canopy control switch to CLOSE until canopy lowers to half closed. Release switch and check that canopy stops. Place switch to OPEN. Canopy moves to full open and switch automatically returns to HOLD. Return switch to CLOSE and make sure canopy closes and locks and the CANOPY caution goes out.
16. (A) Inflight refueling probe - CYCLE
    The refueling probe extends or retracts in 6 seconds. Have ground crew check that the probe light is on with the probe extended.
17. (A) Speed brake - CYCLE
    Speed brake extends or retracts in 3 seconds maximum. The SPD BRK light is on anytime speed brake is not fully retracted. HYD2 pressure shall not change during speed brake operation.
18. (A) Launch bar - FUNCTIONAL CHECK
19. (A) Arresting hook - FUNCTIONAL CHECK
20. (A) MC1 and MC2 - CYCLE
    Select MENU on the DDI and place the misson computer (MC) switch to 1 OFF. Check that DDI MENU options BIT, CHKLST, ENG, ACL and ADI are removed and MC1 caution appears. Return switch to NORM and ensure the MENU options return and the MC1 caution is removed. Place (MC) switch to 2 OFF and check that MENU option STORES is removed and MC2 caution appears. Return switch to NORM and ensure the MENU option STORES returns and MC2 caution is removed.

TAXI

1. (A) Brakes - TEST
   When leaving the chocks, check brakes with anti-skid OFF. Check that ANTI SKID advisory is displayed. Check brakes with anti-skid ON during taxi.
2. (A) Nosewheel steering - CHECK
   Perform a qualitative check in LO and HI gain modes. Check that steering is disengaged with the paddle switch held.

EGT and N_1 Limits

(BELOW 4,000 FEET AND MIL POWER OR AFTERBURNER)

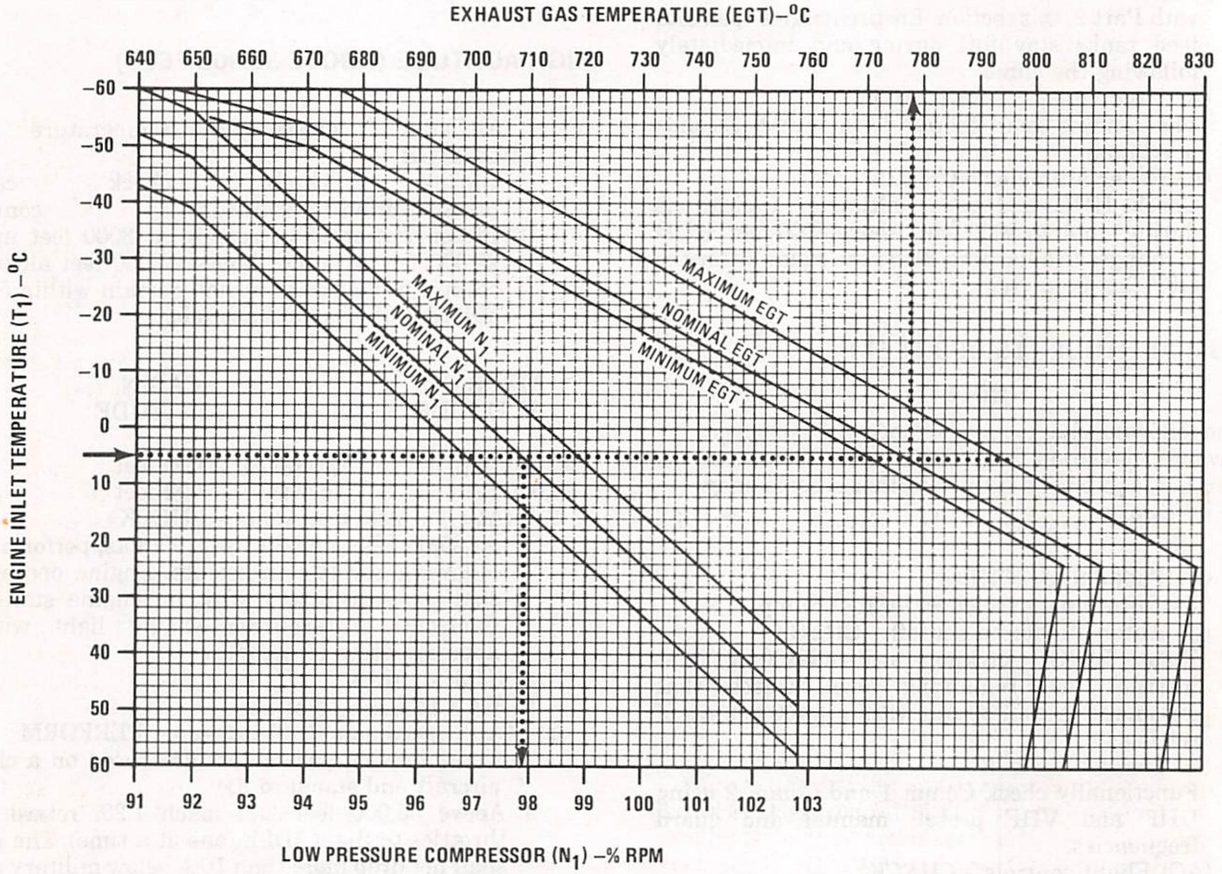

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Figure 3-9. EGT and N_1 Limits

3. (A) Emergency brakes – CHECK
No appreciable change in performance should be observed compared to the normal system.

NOTE

Anti-skid system is inoperative during emergency brake system operation.

BEFORE TAKEOFF

1. (A) Before takeoff procedures – PERFORM

Perform the before takeoff procedures in accordance with Part 2, this section.

2. (A) Parking brake caution – CHECK
   - a. Parking brake – ON
   - b. Both throttles – ABOVE 80% RPM
   - c. PARK BRAKE caution – ON
   - d. Parking brake – OFF

3. (A) HI and standby magnetic compass – CHECK
After runway lineup, compare HI heading and standby magnetic compass with runway heading. The HI should be within ±3° and standby magnetic compass should be within limits of compass correction card.

4. (AB) Engines – RUN UP (one at a time)

Low pressure compressor (N_1) rpm and exhaust gas temperature (EGT) are scheduled as a function of engine inlet temperature (T_1), refer to figure 3-9. High pressure compressor (N_2) rpm varies with N_1 and EGT and should not be used to reject an engine when N_1 and EGT are within limits unless N_2 is above maximum rpm (103%).

- a. INLET TEMP – Varies with OAT
- b. N_1 rpm – 94 to 103%
- c. N_2 rpm – 92 to 100%
- d. EGT – 715 to 830° (852°C MAX)
- e. FF – 6000 to 9000 pounds per minute
- f. NOZ POS – 0 to 57%

g. OIL PRESS – 100 to 160 psi
h. VIB – Display not valid
i. FUEL TEMP – 80°C maximum

TAKEOFF

1. (AB) Afterburner takeoff – PERFORM
Perform an afterburner takeoff in accordance with Part 2, this section. Ensure nozzles open and feed tanks stay full during and immediately following the climb.
2. (A) Landing gear – RETRACT
The landing gear should retract in 6 seconds maximum.
3. (A) Radar altimeter – CHECK
Check HUD and radar altimeter indications during climb to 5000 feet. Above 5000 feet, HUD R changes to a flashing B and the radar altimeter OFF flag is in view.

MEDIUM ALTITUDE (15,000 FEET)

NOTE

The following checks may be made at 15,000 feet; however, deviation from this altitude because of weather, equipment status or other reasons may be necessary.

1. (A) Fuel dump – CHECK
Perform functional check of fuel dump.
2. (A) Automatic dump shutoff – CHECK
Rotate BINGO set knob until index (bug) is at internal fuel remaining level. Check that automatic shutoff occurs within ±400 pounds of setting.
3. (A) Comm – CHECK
Functionally check Comm 1 and Comm 2 using UHF and VHF preset, manual and guard frequencies.
4. (AC) Flight controls – CHECK
At 300 to 350 knots check for normal damping characteristics following small pitch, roll and yaw inputs.
5. (A) Fuel transfer – MONITOR
Periodically monitor fuel quantity during flight ensuring normal fuel transfer occurs.
6. (A) IFF – CHECK
7. (A) Cabin pressure – CHECK
Check cockpit pressure is 8000 ±1000 feet
8. (AC) AFCS – CHECK (after 7.0 PROM)
   a. A/P – At 350 knots, 15,000 feet with bank angle ≤ 5°, engage A/P (autopilot) switch. Check that airplane maintains heading.
   b. Attitude hold — Bank airplane 45° left using control stick steering (CSS). Check that airplane maintains attitude. Bank airplane 45° right using CSS. Check that airplane maintains attitude. Input ±10° pitch commands using CSS. Check that airplane maintains heading and attitude
   c. Heading select – Select 30° left heading change with the HDG set switch. Select HSEL option. Check that heading hold is reestablished after selected heading is captured. Repeat with 30° right heading change
   d. Barometric altitude hold – Select BALT option during a 4000 feet/minute climb. Check that altitude is captured and maintained. Repeat during 4000 feet/minute dive. Perform45° bank turn. Check that altitude is maintained within ±100 feet.
9. (AB) ATC cruise mode – CHECK (after 7.0 PROM)
Engage ATC cruise mode between 300 and 350 knots. Ensure system maintains engaged airspeed in level flight and banked turns.

HIGH ALTITUDE (ABOVE 30,000 FEET)

1. (A) Cabin pressurization/temperature – MONITOR
During climb, check cabin pressurization/temperature control. Pressurization shall remain at 8000 feet up to 23,000 feet altitude. Above 23,000 feet altitude, cockpit pressurization shall remain within 5 psi differential of actual altitude.

AIRPLANE ALTITUDE	CABIN ALTITUDE
30,000 feet	10,000 to 12,000 feet
40,000 feet	15,000 to 17,000 feet

2. (AB) Throttle transients – CHECK
At 35,000 feet and 200 to 220 knots, perform the following throttle transients. Engine operation shall be satisfactory with no engine stalls or flameouts. Afterburner should light within approximately 15 seconds.
   a. IDLE to MAX
   b. MAX to IDLE to MAX
3. (AB) Speed run/RPM lock-up – PERFORM
The following parameters are based on a clean aircraft and standard day.
   a. Above 35,000 feet and mach 1.23, retard the throttles to flight IDLE (one at a time). The rpm shall not drop more than 10% below military rpm with throttles at flight idle.
4. (A) Tank 1 and 4 transfer – CHECK

Airplanes thru 161519 –

a. Tank 4 depletes faster than tank 1 at low power settings.
b. Tanks 1 and 4 deplete together at high power settings.
c. Tank 4 quantity not more than 1,300 pounds (2,000 pounds for TF/A-18A) greater than tank 1 quantity.

Airplanes 161520 and up –

a. Tanks 1 and 4 fuel quantities fall within allowable limits, which is verified if the CG caution is not displayed.
b. No CG caution display.
c. No more than 2,000 pounds (1,300 pounds for TF/A-18A) remaining in tank 1 when tank 4 empties.

5. (AC) Spin recovery mode (SRM) – CHECK (if CG within limits)

a. Check fuel transfer. Ensure CG is within limits. If CG is out of limits, do not check SRM.
b. In 1G wing-level flight at 30,000 feet and 200 knots, spin recovery switch - RCVY
c. Check both DDI's - SPIN MODE
d. Decelerate to 140 knots (125 knots after 7.0 PROM)
e. Check both DDI's - SPIN MODE ENGAGED
f. Do not generate sustained yaw.
g. Accelerate above 175 knots (245 knots after 7.0 PROM)
h. Check both DDI's - SPIN MODE
i. Spin recovery switch - NORM

18,000 TO 10,000 FEET

1. (A) Radar - FUNCTIONAL CHECK
   a. Air-to-air mode - CHECK
   b. Air-to-ground - CHECK
2. (A) Inertial navigation system (INS) - CHECK
   Check present position error using tacan position update. Record and reject update. Functionally check designate and overfly.
3. (A) HUD - FUNCTIONAL CHECK
   In the navigation master mode, check that the following displays for WYPT or TCN are present: Heading, airspeed, altitude, barometric setting (for 5 seconds after set), angle of attack, mach number, aircraft G, bank angle scale, velocity vector, flight path/pitch ladder, steering arrow and distance to WYPT or TCN. WYPT is displayed to the right of the distance for waypoint navigation and a 3 letter station identifier is displayed to the right of the distance for tacan navigation. Check that the displays agree with the corresponding values on the HI. Check the VTR/HUD camera. Check that either DDI will display the HUD symbology.
4. (A) Flight instruments - CHECK
   a. Standby vertical velocity indicator - During level 1 G flight, the VVI indication is ±100 feet per minute or less. During altitude changes pointer movement is smooth.
   b. Attitude reference indicator - Perform a 360° roll right and left. No gyro tumble is permitted. Perform a loop. Gyro indications must be smooth. During loop check that the HUD flight path/pitch ladder pitch lines are angled toward the horizon.
   c. Standby airspeed indicator - Check that airspeed agrees with airspeed displayed on the HUD. During airspeed changes pointer movement is smooth.
   d. Standby altimeter - Check that altitude agrees with barometric altitude displayed on the HUD. During altitude changes, pointer movement is smooth and drum movement does not hang up during thousand-foot changes.

NOTE

The HUD airspeed and altitude values are corrected by the ADC and the standby instruments are not. Therefore, under certain flight conditions the standby instruments may not agree with the HUD.

   e. Horizontal indicator - Check HI displays for proper WYPT and TCN steering.
      (1) Hold heading set switch to the right and check that heading bug moves clockwise and digital command heading display agrees with bug setting. Hold switch to the left and check that heading bug moves counterclockwise and digital command heading display agrees with bug setting.
      (2) Hold course set switch to the right and check that steering arrow rotates clockwise and digital course display increases. Hold course set switch to the left and check that the steering arrow rotates counterclockwise and digital course display decreases.
      (3) Perform a course intercept using both WYPT and TCN steering. The steering arrow shall correspond to the steering arrow on the HUD. All display movement shall be smooth.
      (4) When established on a tacan radial check that bearing and range accuracy are within reasonable estimates.
5. (A) Data link - CHECK (after 7.0 PROM, if possible)
6. (AB) Restart - PERFORM
   a. Spooldown - At 18,000 feet and mach 0.6, place left throttle to OFF. As rpm drops to 50%, advance throttle to IDLE. Maximum EGT during restart is 815°C. Repeat check for right engine.
   b. Windmill - At 15,000 feet and mach 0.75, place the left throttle to OFF. After rpm stabilizes, advance throttle to IDLE. Repeat check for right engine.
   c. Crossbleed - At 15,000 feet and mach 0.4, crossbleed start one engine. Allow the engine windmill rpm to stabilize before advancing the throttle.
7. (A) G loading - CHECK
   Maneuver to attain +5.0G then push-over to −1.0G. Do not exceed 5 seconds during negative G flight. Check that all equipment continues to function during and after the G loading maneuvers. Check for foreign objects in the cockpit during negative G flight.

10,000 FEET TO LANDING

1. (A) Fuel transfer - MONITOR
   a. Wing tanks deplete to 0 to 200 pounds before tank 1 or 4 falls below 200 pounds and wing tanks empty following FUEL LO caution.
   b. Feed tanks remain full until tanks 1 and 4 fall below 200 pounds in non-afterburner operation.
2. (AB) Throttle transients - CHECK
   At 10,000 feet and 0.75 mach perform the following throttle transients. Afterburner should light within approximately 8 seconds.
   a. IDLE to MAX
   b. MAX to IDLE to MAX
3. (AB) APU airstart - PERFORM
   At 7500 feet and 200 to 250 knots, turn one generator OFF and perform an APU airstart. Turn APU off after satisfactory indication of proper operation and cycle generator switch.
4. (A) ADF receivers - CHECK
   Check accuracy of ADF 1 and ADF 2. Bearing accuracy is as follows:
   a. Off the nose (0° relative bearing) ±5°.
   b. Off the wing tip (90° and 270° relative bearing)

±20°.

c. Off the tail (180° relative bearing) no specified accuracy.

5. (A) Automatic speed brake retract – CHECK
Extend the speed brake then extend flaps. Ensure speed brake retracts.

6. (A) Landing gear warning light/warning tone – CHECK
Below 7000 feet with the landing gear handle UP, reduce airspeed below 175 knots and establish a rate of descent greater than 250 feet per minute. Check that the gear handle warning light flashes and the warning tone comes on.

7. (A) Emergency landing gear system – CHECK
Below 180 knots, pull landing gear circuit breaker then place the landing gear control handle down. Rotate the landing gear control handle 90° clockwise and pull to detent. Ensure handle is pulled to detent and that detent is engaged. Check that the gear indicates down within 30 seconds. Hold the hydraulic isolate switch in ORIDE until the APU ACCUM caution goes out and the emergency brake accumulator gage is in the green. Reset the emergency landing gear control handle by pushing in, then rotating 90° counterclockwise. Reset landing gear circuit breaker.

CAUTION

To prevent damage to the main landing gear side brace overcenter lock linkage, the landing gear handle must be outboard before resetting the handle from emergency to normal.

8. (A) AOA tone – CHECK
With flaps HALF or FULL, increase AOA to 15° (12° after 7.0 PROM) and check that AOA tone comes on.

9. (A) Landing gear – RETRACT

10. (AC) Flaps auto retract – CHECK

With 5.3.1 PROM –

a. Slowly increase airspeed. Flaps should retract to HALF at 165 ±10 knots.

b. Place flap switch to HALF and slowly increase airspeed. Flaps should retract to AUTO at 210 ±10 knots.

After 7.0 PROM –

a. Increase airspeed. Flaps should retract to AUTO at 250 ±10 knots (amber flap light).

11. (A) Instrument landing system/ACLS – FUNCTIONAL CHECK (if facility available)
Perform a functional check of the instrument landing system and, after 7.0 PROM, the ACLS.

12. (A) AOA indexer brightness – CHECK AND SET
With landing gear down check brightness from DIM thru BRT then set to the desired brightness.

13. (A) Radar altitude hold – CHECK (after 7.0 PROM)

14. (A) ATC approach mode – FUNCTIONAL CHECK (after 7.0 PROM)
Perform a functional check of the ATC mode.

AFTER LANDING

1. (A) Anti-skid – CHECK
Above 75 knots apply full brake pressure. Check that anti-skid action is smooth and exhibits no left or right pulling tendencies.

2. (A) Nosewheel steering high mode – CHECK (after 7.0 PROM)
At reduced taxi speed, unlock the wing fold and press and release the nosewheel steering button. Ensure nosewheel steering goes to high gain and stays in high gain.

3. (A) INS terminal error – RECORD
Maximum error value for a gyro compass alignment is 1.0 nautical miles per hour of operating time for 1 flight or an average of 1.5 nautical miles per hour of operating time for 2 flights.

4. (A) BIT/BLIN – CHECK

5. (AB) Engine shutdown – L and R FIRE LIGHTS PUSH
With engines at idle, shut down both engines using the left and right FIRE warning lights. After indication of decreasing rpm, place both throttles to OFF and reset FIRE lights. With the engines at IDLE, it may take as long as 40 seconds before the engines shut down.

CHECKFLIGHT REQUIREMENTS (AFT COCKPIT)

This Aft Cockpit section outlines only the additional checks to establish acceptance standards for the systems peculiar to the TF/A-18A airplane. The checks and success criteria specified in the Front Cockpit section also apply to the TF/A-18A airplane. Instrument and indicator reading, warning lights, and radar and navigation displays in the aft cockpit will be compared throughout the flight with corresponding information available from the front cockpit. There is no requirement for an aft crewmember during an FCF; however, if an aft crewmember is available, the following checks should be made.

BEFORE TAXI

Perform the before taxi procedures in accordance with Part 2, this section.

1. (A) Fuel quantity gage – CHECK
During front cockpit BIT, make sure the TOTAL and INTERNAL counters agree with front cockpit indications ±200 pounds.

2. (AC) Speed brake – CYCLE
Check operation of the speed brake from the rear cockpit.

3. (A) Attitude reference indicator – CHECK
Check that attitude reference indicator is adjustable. Minimum adjustment is ±5°.

4. (A) Standby altimeter – SET AND CHECK

Set reported barometric pressure in window and check that altimeter reads within ±60 feet of ramp elevation.

5. (A) Warning/caution lights - TEST
   Check for proper operation of the warning and caution lights.
6. (A) DDI's - ON
   Set the brightness or contrast as desired.

TAXI

1. (A) Brakes - CHECK
   When leaving the chocks, check brakes with anti-skid OFF. Check that ANTI SKID advisory is displayed. Check brakes with anti-skid ON during taxi.
2. (A) Nosewheel steering - CHECK
   Perform a qualitative check in LO and HI gain modes. Check that steering is disengaged with the paddle switch.
3. (A) Emergency brakes - CHECK
   No appreciable change in performance should be observed compared to the normal system.

NOTE

Anti-skid system is inoperative during emergency brake system operation.

MEDIUM ALTITUDE (15,000 FEET)

1. (A) Comm - CHECK
   Functionally check Comm 1 and Comm 2 using UHF and VHF preset, manual and guard frequencies.

HIGH ALTITUDE (ABOVE 30,000 FEET)

1. (A) Cabin pressurization - MONITOR
   During climb, check cabin pressurization control. Pressurization shall remain at 8000 feet up to 23,000 feet altitude. Above 23,000 feet altitude, cockpit pressurization shall remain within 5 psi differential of actual altitude.

AIRPLANE ALTITUDE	CABIN ALTITUDE
30,000 feet	10,000 to 12,000 feet
40,000 feet	15,000 to 17,000 feet

18,000 TO 10,000 FEET

1. (A) Flight instruments - CHECK
   a. Standby vertical velocity indicator - During level 1 G flight, the VVI indication is ±100 feet per minute or less. During altitude changes pointer movement is smooth.
   b. Attitude reference indicator - During the 360° roll right and left. No gyro tumble is permitted.
   c. Standby airspeed indicator - Check that airspeed agrees with airspeed displayed on the HUD. During airspeed changes pointer movement is smooth.
   d. Standby altimeter - Check that altitude agrees with barometric altitude displayed on the HUD. During altitude changes pointer movement is smooth and drum movement does not hang up during thousand-foot changes.

10,000 FEET TO LANDING

1. (AC) Flight controls and throttles - FUNCTIONALLY CHECK
2. (A) Emergency landing gear system - CHECK
   Below 180 knots and before the landing gear is extended with the emergency system from the front cockpit, pull the emergency landing gear handle until it locks in the detent. Check that gear indicates down within 30 seconds. Have front crewmember move the landing gear handle down and hold the hydraulic isolate switch to ORIDE until the APU ACCUM caution goes out and the emergency brake accumulator gage is in the green. Reset the rear emergency landing gear handle then have front crewmember raise the landing gear.

AFTER LANDING

1. (A) BIT - CHECK DSPL, UFC AND EMI

SECTION IV

FLIGHT CHARACTERISTICS

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HANDLING QUALITIES (5.3.1 PROM)

The flight control system (FCS) is designed to provide both stability and controllability. Stability, the measure of the airplane's resistance to external disturbing forces, provides a predictable and steady platform for accomplishing various weapons delivery tasks. Controllability, the measure of ease of changing the airplane's speed, direction and acceleration provides the means for flying the airplane aggressively. The flight control system achieves both stability and controllability by monitoring aircraft motion and pilot input, applying preprogrammed control laws, and then commanding control surface movement to provide the responsiveness and maneuverability of an agile fighter and the steady platform of a good bomber. The FCS provides good flying qualities throughout the flight envelope so that most of the pilot's attention may be directed to mission related tasks.

AUTO FLAP CONFIGURATION

The FCS control laws create slightly different handling qualities than those of most airplanes. The most apparent characteristic is the excellent hands-off stability. Damping about all axes is high. Static longitudinal stability is neutral since the FCS attempts to keep the airplane in 1 G, zero pitch rate flight. Longitudinal trim is used to bias (adjust) the reference load factor or pitch rate as the pilot desires. Longitudinal and lateral trimming are not required as the airplane accelerates or decelerates through most of the flight envelope. Once an attitude is set, the airplane will tend to hold that attitude without further stick inputs, even through the transonic speed regime. This characteristic reduces stick forces with changing airspeed, lowering pilot workload for most tasks. However, some flight tasks are made more difficult because the FCS attempts to maintain 1 G flight. For example, during a dive or steep zoom climb, a small but constant forward stick force is required to maintain a constant attitude.

Airspeed changes cannot be sensed through changing stick forces. Difficulty may be encountered when trying to maintain a desired airspeed during high workload tasks such as instrument penetration/approach. This can be overcome by setting up a frequent scan of the airspeed readout on the HUD. It may be useful to use the fuel flow gage as the primary thrust instrument and to memorize certain "gouge" fuel flows. The FCS incorporates an angle-of-attack (AOA) feedback above 15° AOA to provide a cue to increasing AOA. To increase AOA above 15°, either nose-up trim or aft stick must be applied. Maximum nose-up trim will provide about 20° AOA. To increase AOA above 20°, aft stick is required. The maximum steady-state AOA with full aft stick (50 pounds stick force) is 55° to 60°. If the aft stick is released, the FCS will command nose-down pitch until the AOA is reduced below 15° (20° with full nose-up trim). At this time, the AOA feedback is removed and the FCS again seeks to maintain 1 G zero pitch rate flight.

Longitudinal control effectiveness and pitch damping are satisfactory up to 35° AOA so long as the CG is within the allowable limits. Because of the artificial pitch stability provided by the CAS, the pilot will probably not perceive any changes in flight characteristics due to CG movement caused by fuel transfer or stores delivery. With the CG slightly aft of the aft limit, the CAS will augment the pitch stability to a point where the pilot may not experience problems during normal maneuvering. However, if the FCS should degrade to MECH or pitch DEL with the CG aft of the aft limit, airplane stability will be seriously degraded and aircraft control may be lost.

In maneuvering flight, there is a light but constant stick force per G (about 3 ½ to 4 ½ pounds/G). Unlike many other airplanes, maneuvering stick forces do not vary significantly over the entire operating envelope so long as the AOA is less than 15°. Above 15° AOA, where AOA feedback is active, maneuvering stick forces are increased significantly. Because of this large change in stick force feedback cues, pilots must use caution when aggressively maneuvering in the 15° AOA region to prevent airframe over-G. For example, it is possible that a pilot may become accustomed to the high stick forces required to maneuver during a slow speed scissors and may subsequently over-G the airplane after an extension for airspeed due to the relatively light stick forces below 15° AOA. In the worst case, an airspeed increase as small as 50 knots (275 to 325 knots) can almost halve the stick force required to pull 5 ½ G (38 pounds to 20 pounds). There is also an over–G potential associated with abrupt longitudinal stick inputs at high subsonic speed where a transient G overshoot of 1 G or 2 G may occur. Smooth longitudinal stick inputs will prevent this G overshoot tendency.

CAUTION

Above 300 knots, avoid abrupt longitudinal stick movement which can cause large G overshoot.

Maximum lift and maximum instantaneous turn rate occur at about 35° AOA; however, drag rises rapidly above 20° to 25° AOA. The region above 25° AOA is useable but high energy loss will result. The lateral controls are effective in controlling bank angle and roll rate up to about 20° AOA. Lateral control diminshes rapidly above 20° AOA such that lateral stick is ineffective above 25° AOA. Rudder inputs are effective in controlling the lift vector up to about 30° AOA. Above 35° AOA, the rudders also rapidly lose effectiveness and the airplane's bank angle cannot be controlled. Pitch control is good to 45° AOA although longitudinal stick force at this AOA is very high.

Use caution during low–speed overhead maneuvers as the airplane tends to enter a tailslide. For example, aft stick must be increased near the top of a slow speed loop. If aft stick is not increased, the AOA feedback will command enough nose down stabilator (full nose down if necessary) to reduce the AOA below 15° which can result in a relatively steady, inverted, nose–high attitude. Apply sufficient aft stick (25 to 30 pounds) while enough airspeed is still available to establish and maintain a positive pitch rate. Aft stick should be maintained until the nose is below the horizon and airspeed is increasing. Neutralizing the controls near the top of a low–speed overhead maneuver is not a good practice because the nose will not tend to fall through.

Directional stability and damping are good through most of the flight envelope. There is a poorly damped, easily excited, dutch roll (wing rock) at 15° to 20° AOA. This dutch roll is not dangerous but will hinder attempts to precisely control the airplane. Adverse yaw (yaw opposite to lateral stick) can generate excessive sideslip during large lateral stick displacements in some parts of the flight envelope. At high Mach, especially with the TF/A airplane or the F/A airplane with a centerline tank, large lateral stick displacement will produce enough sideslip to exceed the structural limits of the vertical tail. Full lateral stick displacement at low speed and moderate AOA (0° to 20°) also causes excessive sideslip (more than 10°) which may result in a departure.

Inertial pitch coupling occurs when rolling at AOA above 20°. It is characterized by a rapid but smooth increase in AOA during high yaw rate rolls started at a moderate AOA. Typical maneuvers that can cause this type of coupling are high–G barrel rolls, rudder rolls, and to a lesser extent, aileron rolls. The airplane is fuselage loaded which means that the inertial pitching forces are inherently strong. This, combined with the relatively high roll/yaw rates available at 20° to 25° AOA, makes pitch coupling probable. The yaw rate must be actively controlled during aggressive maneuvering to avoid pitch coupling. Avoid yaw rates in excess of 25°/second. If a yaw rate over 25°/second (onset of beeping tone) is maintained for more than a few seconds, the AOA will rapidly rise to 35° to 50°. Full forward stick will have essentially no effect on the AOA as the inertial forces are much more powerful than the aerodynamic restoring forces of the stabilators. If the AOA is over 35°, the yaw rate warning tone is replaced by the AOA warning tone and yaw rate warning is not available.

Kinematic pitch coupling can occur during lateral stick rolls at an AOA less than 20°. This phenomena can result from pure lateral stick, coordinated stick and rudder, or cross control inputs. Only a pure rudder roll appears not to couple. It is characterized by a violent unloading and pitch to negative AOA. Below 200 knots, it can occur with less than 360° roll. At higher speeds it is not so pronounced. Negative AOA over −50° and load factors less than −2G have been abruptly encountered. Adverse yaw plays a significant part in kinematic pitch coupling. The airplane is limited to 360° of roll due to kinematic pitch coupling.

The FCS exhibits other predictable characteristics. A pitch bobble occurs during speedbrake extension/retraction, especially during high speed flight. The airplane exhibits a small transonic pitch–up when decelerating rapidly through the Mach 1.0 - .95 region while maintaining a high load factor. This pitch–up seldom is more than a 1 G increment in load factor. This transonic pitch–up is not noticeable during 1 G deceleration or slow decelerations at high load factors. It is common for the airplane to unload when performing a rapid aileron roll. This characteristic occurs to some extent throughout the flight envelope. A longitudinal pilot–induced–oscillation (PIO) may occur if aggressive and precise control of pitch is attempted at high airspeeds, especially at higher altitudes. This may be encountered during tight formation flight above about 400 knots. The tendency for a PIO is aggravated with an aft CG and and can be instigated by the pitch bobble associated with a speed brake transient. If necessary, the stick should be released to stop a PIO.

Rolling performance is good over most of the flight envelope. The FCS reduces roll rates with external wing stores aboard. The roll rate is reduced at low altitude and high speed (above 550 knots) due to excessive wing twist. Because the roll rate is low in this region, these airplanes should not be rolled inverted at low altitude. During maximum deflection aileron rolls, there is a tendency to overshoot the desired bank angle. In some instances, a lateral PIO can be generated when trying to precisely stop a full deflection aileron roll. A lateral PIO will stop immediately if the control stick is released.

Landing in the auto flap configuration is not recommended as the auto flap up gains may cause a lateral PIO.

HALF OR FULL FLAP CONFIGURATION

Unlike the auto flap configuration, the FCS incorporates a full time AOA feedback in the half or full flap mode. For this reason, longitudinal trim is required when changing

AOA and, therefore, airspeed. When the airplane is trimmed to an AOA, it will tend to maintain that AOA and significant stick force is required to fly at another AOA. AOA feedback is increased above 15° AOA. An AOA warning tone comes on at 15° AOA. The throttles are very sensitive in the thrust range used for landing approach. This, combined with rapid engine acceleration characteristics, makes it easy to overcontrol thrust on the glide slope.

Airplane response to rudder pedal input varies significantly with AOA. Above optimum approach speed, light rudder pedal force can generate a large sideslip angle. Below optimum approach speed, response to rudder pedal input is greatly reduced. The pilot must be constantly aware of these characteristics during single-engine approach/waveoff. If the aircraft decelerates to more than 10° to 12° AOA with A MAX-IDLE thrust split, directional control will almost certainly be lost. A slight reduction in AOA should restore directional control. Sideslip response to rudder pedal force is nonlinear. This characteristic is encountered during cross control sideslip maneuvers. Increasing rudder pedal force is required for increased sideslip up to about 6° sideslip. At this point, sideslip will increase with no increase in rudder pedal force. Above 8° sideslip, required rudder pedal force decreases. Avoid use of cross controls and avoid flying in this unstable region. After a crosswind takeoff, make a shallow upwind turn to maintain the ground track down the runway. During crosswind landing, crab into the wind and maintain balanced flight. Take out half the crab just before touchdown. With over 15 knots crosswind, make a flared landing.

Formation flap transitions (cruise to landing or takeoff configuration) can result in a lateral PIO. This tendency is aggravated when the flaps are lowered above 190 knots. Pilot gain also plays a large part in determining the likelihood of a PIO. Pilot gain can best be reduced by increasing lateral separation from the lead airplane. 180 knots is recommended for transition to the landing configuration. Transition from HALF or FULL to AUTO generally poses no problems.

Full lateral stick rolls in the landing configuration will likely cause a large bank angle overshoot. An aggressive roll to a target bank angle of 45° may result in a transient overshoot to 90° bank or more. For this reason, do not use more than ½ lateral stick with the flaps HALF or FULL.

SPIN RECOVERY MODE (SRM)

Flight characteristics in SRM differ significantly from those of the normal CAS mode. All FCS feedbacks, interconnects, and gain schedules are removed, leaving the FCS in essentially a three axes DEL mode. Because the artificial yaw stability features of CAS are not available in SRM, the directional axis is very loose. The unaugmented directional stability is weak and the nose tends to wander. Significant pilot compensation is required to maintain zero sideslip, balanced flight. Because the lateral control surfaces are not washed out with increasing AOA as they are in CAS, lateral stick can generate excessive yaw. The airplane is very susceptible to nose-slice departure with even small lateral stick deflection. An aft CG significantly adds to the possibility of an AOA hang-up if departure occurs.

WARNING

To prevent AOA hang-up, do not intentionally operate in the spin recovery mode if the CG is aft of 25% MAC.

OUT-OF-CONTROL (5.3.1 PROM)

The flight control system incorporates a number of features which augment the airplane's natural departure and spin resistance. With the FCS in the CAS mode, very aggressive maneuvering is possible without departure provided the airplane remains within the established flight envelope. AOA or yaw rate excursion, lateral stick deflection, or CG location which exceed those published in the operating limitations section of this manual may significantly degrade the departure/spin resistance provided by the FCS.

DEPARTURES

Departures occur primarily in the form of a nose slice. The airplane's directional stability is less at 40° to 45° AOA than at either higher or lower AOA. Normally, the CAS yaw stability augmentation will prevent departure even in the 40° to 45° AOA region. Departures are most likely when the AOA is stabilized in the 40° to 45° range, with a high load factor, and at high speed (high energy). The airplane is more departure prone at lower altitudes. High lateral asymmetry significantly reduces departure resistance above 20° AOA. Normally, asymmetric thrust, including one engine in maximum afterburner and the other at idle or flamed-out, will not in itself, cause a departure. However, asymmetric thrust combined with aggravating flight controls may cause a directional nose slice departure under normally benign conditions. Lower altitudes will aggravate asymmetric thrust effects due to the larger thrust differential.

Departures are characterized by a yaw divergence (nose slice) followed by an uncommanded roll in the same direction as the initial yaw. The initial phase of a nose slice departure is not particularly violent or disorienting compared to other tactical jet airplanes. Directional departures initiated from low (1-2) G at high altitude are characterized by low to moderate initial yaw rates and very low cockpit side forces. For this reason, a pilot may not preceive an out-of-control situation for a number of seconds after the actual departure commences. If an asymmetric load exists at departure, the airplane will tend to yaw and roll away from the heavy wing.

Neutral controls and symmetric thrust (throttles to IDLE) is effective in regaining control following departure. If the airplane does not respond to neutral controls after allowing a few seconds for post-stall gryations to cease, it has most likely entered the low yaw rate spin mode or an AOA hangup and further pilot action may be required to effect a recovery.

SPINS

Three more or less distinct spin modes (all upright) have been observed and an inverted flight spin mode is predicted from wind tunnel and simulator data. The airplane is very reluctant to enter any spin with the CAS operating and within the flight limitations contained in this manual.

Low Yaw Rate Mode

The low yaw rate spin mode is characterized by AOA in the 50° to 60° range and a very low yaw rate (0° to 40°/second). This mode can be very smooth, although some mild pitch, roll, and yaw motions are normally experienced. The low rate spin is not normally violent or disorienting and cockpit forces are low. Low cockpit forces and low yaw rate make this mode difficult to recognize as a spin. Rate of descent for an established low yaw rate spin is approximately 20,000 feet/minute. As much as 5000 feet may be lost per turn. Entry to the low yaw rate spin mode can occur when operating between 50° and 60° AOA; however, the yawing moment necessary for entry is difficult to generate in this AOA range. A low yaw rate spin entry is much more likely when large sustained lateral and/or directional controls are applied at lower AOA. Excessive yaw rate under these conditions can inertially couple into the pitch axis and generate AOA overshoot into or beyond the 50° to 60° range. Asymmetric thrust and/or asymmetric store loadings significantly reduce the airplane's resistance to the low yaw rate spin.

Intermediate Yaw Rate Mode

The intermediate yaw rate spin mode is characterized by higher average yaw rates than the low yaw rate mode (20° to 80°/second). This mode is very oscillatory in pitch and roll. AOA will vary between 40° to 80° and bank angles between 60° left and right. Bank angle variations may increase to the point where the airplane will execute one or more 360° rolls while continuing to spin in the same direction. Rate of descent is about 21,000 feet/minute. Altitude loss per turn is about 1500 feet. Cockpit sideforce can be as high as 1 G left or right. The airplane will unload (negative G) during 360° rolls. Due to the highly oscillatory nature and the rapid variations in cockpit forces, this spin mode can be very disorienting. The pilot will probably experience difficulty in determining spin direction from visual cues outside the cockpit. Disorientation may be aggravated if the pilot is not securely strapped in. Entry into an intermediate yaw rate spin is unlikely in the clean configuration and more likely with high asymmetric store loading.

High Yaw Rate Mode

The high yaw rate spin mode is characterized by yaw rates in the 100° to 140°/second range and AOA of 80° to 90°. This mode is best described as a smooth flat spin. Small oscillations in pitch and roll have been observed but are not generally perceived by the pilot. Longitudinal forces in the cockpit can be as high as −3.5 G (eyeballs out). Consequently, the pilot will be significantly hindered in recovery unless his shoulder harness is manually locked. Because this mode is smooth and flat, the pilot should experience no difficulty in determining spin type or direction. Rate of descent for an established high yaw rate spin averages 18,000 feet/minute (1000–1500 feet/turn). Entry into this mode is possible only with sustained (more than 15 seconds) full pro–spin lateral stick with the FCS in the spin recovery mode.

Spin Recovery

Spin recovery characteristics from any mode with the FCS in the CAS mode are very poor due to the reduced differential stabilator and aileron authority at higher AOA. With the FCS in the spin recovery mode (SRM), spin recovery characteristics are excellent. The command arrow on the DDI indicates the correct stick position for recovery from either an upright or inverted spin. In the SRM, application of lateral stick in the direction of the command arrow on the DDI will cause a rapid reduction of yaw rate. After the yaw rate is stopped (arrow on DDI disappears) forward stick may be required to reduce the AOA below 45°. It may impossible to reduce the AOA before the yaw rate is completely stopped due to inertia coupling especially with an aft CG. Recovery from the high yaw rate spin mode can be made within 2½ turns. Lower yaw rate modes require a correspondingly lesser number of turns for recovery. Approximately 12,000–14,000 feet are required to effect recovery from a fully developed spin (from application of recovery controls to dive pull-out).

AOA HANGUP

The airplane exhibits a weak nose–down pitching moment in the 45°–55° AOA region. This characteristic is significantly aggravated with an aft CG and some external store loadings. Three external fuel tanks appear to be the most destabilizing. AOA hangup is characterized by AOA stabilization near 50° and lack of response to forward stick. With a slightly forward CG, the AOA will respond to longitudinal stick but the response is very sluggish. As much as 15 seconds may be required to reduce the AOA below 35°. With the CG further forward, the likelihood of an AOA hangup is reduced proportionally and pitch response is more positive. Lateral–directional oscillations, perceived as wing rock by the pilot, will aggravate the AOA hangup and the hangup may occur at a CG as much as 4% MAC further forward than it would occur without wing rock. Certain store loadings (centerline tank) may contribute to onset of lateral–directional oscillations. AOA hangup occurs most often during the final portion of a spin recovery after the yaw rate is stopped and from departures at near zero airspeed (vertical manuevers). AOA hangup has also occured following a nose–slice departure and during a very smooth approach to a 1 G stall. Recovery from AOA hangup can best be made by neutralizing controls if the FCS is in CAS (the AOA feedback will drive the stabilators full nose down) or by full forward stick if the FCS is in the SRM mode. Extraordinary patience is required since AOA response, in the worst case, may be very slow. If the airplane rolls inverted and stabilizes, aft stick will be required for recovery.

CG EFFECTS

Above 20° AOA, response to nose–down commands degrades as the CG moves aft of 24% MAC. At low fuel states, use care to avoid exceeding AOA or acceleration limits. Refer to Landing With Aft CG, section V.

FLIGHT CHARACTERISTICS WITH EXTERNAL STORES

Handling qualities with wing stores are satisfactory so long as the flight control system is operating normally (full CAS) and AOA, CG, and asymmetric store loading restrictions are complied with.

ASYMMETRIC STORES

Flight characteristics with asymmetric stores up to 12,000 foot–pounds moment are satisfactory. With an asymmetric moment over 12,000 foot–pounds and AOA over 12°, the resulting uncommanded sideslip can cause the FCS to revert to FIXED GAINS.

CAUTION

- Avoid aggressive roll maneuvers below 225 knots with asymmetric external load.
- Nose slice departure into the light wing is likely when maneuvering above 30° with asymmetry near or above 6000 foot–pounds.
- Nose slice departure is likely when maneuvering above 20° AOA in TF/A–18 airplanes with centerline tank below 6000 foot–pounds lateral asymmetry.

HANDLING QUALITIES (AFTER 7.0 PROM)

The flight control system (FCS) is designed to provide both stability and controllability. Stability, the measure of the airplane's resistance to external disturbing forces, provides a predictable and steady platform for accomplishing various weapons delivery tasks. Controllability, the measure of ease of changing the airplane's speed, direction and acceleration provides the means for flying the airplane aggressively. The flight control system achieves both stability and controllability by monitoring aircraft motion and pilot input, applying preprogrammed control laws, and then commanding control surface movement to provide the responsiveness and maneuverability of an agile fighter and the steady platform of a good bomber.

AUTO FLAP CONFIGURATION

The FCS control laws create slightly different handling qualities than those of most airplanes. The most apparent characteristic is the excellent hands–off stability. Damping about all axes is high. Static longitudinal stability is neutral since the FCS attempts to keep the airplane in 1G, zero pitch rate flight. Longitudinal trim is used to bias (adjust) the reference load factor or pitch rate as the pilot desires. Longitudinal trimming is not required as the airplane accelerates or decelerates through most of the flight envelope. Once an attitude is set, the airplane will tend to hold that attitude without further stick inputs, even through the transonic speed regime. This characteristic reduces stick forces with changing airspeed, lowering pilot workload for most tasks. However, some flight tasks are made more difficult because the FCS attempts to maintain 1G flight. For example, during a dive or steep zoom climb, a small but constant forward stick force is required to maintain a constant attitude. Airspeed changes cannot be sensed through changing stick forces and difficulty may be encountered when trying to maintain a desired airspeed during high workload tasks such as instrument penetration/approach. The FCS incorporates angle of attack (AOA) feedback above 22° AOA. To increase AOA above the feedback AOA 22°, aft stick must be applied. The maximum steady state AOA with full aft stick (50 pounds stick force) is 55° to 60°. If the aft stick is released, the FCS will command nose–down pitch until the AOA is reduced below the feedback AOA (22°). At this time, the AOA feedback is removed and the FCS again seeks to maintain 1G zero pitch rate flight.

Longitudinal control effectiveness and pitch damping are satisfactory up to 35° AOA so long as the CG is within the allowable limits. Because of the artificial pitch stability provided by the CAS, the pilot will probably not perceive any changes in flight characteristics due to CG movement caused by fuel transfer or stores delivery. With the CG slightly aft of the aft limit, the CAS will augment the pitch stability to a point where the pilot may not experience problems during normal maneuvering. However, if the FCS should degrade to MECH or pitch DEL with the CG aft of the aft limit, airplane stability will be seriously degraded and airplane control may be lost.

In maneuvering flight there is a light but constant stick force per G (about 3 1/2 to 4 1/2 pounds/G). Unlike many other airplanes, maneuvering stick forces do not vary significantly over the entire operating envelope so long as the AOA is less than AOA feedback of 22°. Where AOA feedback is active, maneuvering stick forces are increased significantly. There is an over–G potential associated with abrupt longitudinal stick inputs at high subsonic speed where a transient G overshoot of 1G or 2G may occur.

CAUTION

Above 400 knots, avoid abrupt longitudinal stick movement which can cause large G overshoot.

Use caution during low–speed overhead maneuvers as the airplane tends to enter a tailslide. Aft stick must be increased near the top of a slow speed loop. If aft stick is not increased, the AOA feedback will command enough nose down stabilator (full nose down if necessary) to reduce the AOA below feedback AOA which can result in a relatively steady, inverted, nose-high attitude. Apply sufficient aft stick (25 to 30 pounds) while enough airspeed is still available to establish and maintain a positive pitch rate. Aft stick should be maintained until the nose is below the horizon and airspeed is increasing. Neutralizing the controls near the top of a low-speed overhead maneuver is not a good practice because the nose will not tend to fall through.

Inertial pitch coupling occurs when rolling at AOA above 20°. It is characterized by a rapid but smooth increase in AOA during high yaw rate rolls started at a moderate AOA. Typical maneuvers that can cause this type of coupling are high–G barrel rolls or rudder rolls. The airplane is fuselage loaded which makes the inertial pitching forces inherently strong. This, combined with the relatively high roll/yaw rates available at 20° to 25° AOA, makes pitch coupling probable. The yaw rate must be actively controlled during aggressive maneuvering to avoid pitch coupling. Avoid yaw rates in excess of 25°/second. If a yaw rate over 25°/second (onset of beeping tone) is maintained for more than a few seconds, the AOA will rapidly rise to 35° to 50°. Full forward stick will have essentially no effect on the AOA as the inertial forces are much more powerful than the aerodynamic restoring forces of the stabilators. If the AOA is over 35°, the yaw rate warning tone is replaced by the AOA warning tone and yaw rate warning is not available.

The FCS exhibits other predictable characteristics. A pitch bobble occurs during speedbrake extension/retraction especially during high speed flight. The airplane exhibits a small transonic pitch-up when decelerating rapidly through the Mach 1.0 – .95 region while maintaining a high load factor. This pitch-up seldom is more than a 1G increment in load factor. This transonic pitch-up is not noticeable during 1G deceleration or slow deceleration at high load factors. There is a slight tendency to overcontrol pitch during speed brake operation in tight formation at high speed (over 400 knots)

The airplanes roll rate is good throughout the flight envelope. At higher AOA, directional response to rudder inputs between 30° and 35° AOA is sluggish and AOA cannot be controlled precisely. From 35° to 40° AOA, longitudinal and lateral-directional stability decreases. In this region, rudder power is adequate for maintaining essentially wings level flight but large sideslip excursions can occur. Sideslip excursions in the region are further aggravated with the centerline tank loaded. Longitudinal response above 37° AOA is very good; however, precise AOA control is not possible. Full aft stick results in maximum AOA's between 55° and 60°. At full aft stick, in a stall the airplane is stable with small pitch and roll oscillations, large nondivergent sideslip oscillations, and in a high rate of descent (18,000 fpm). Loud airframe vortex rumbling noises are heard in the cockpit in the 55° to 60° AOA region. At Mach numbers greater than 0.8 at AOA greater than 20° roll control is significantly reduced in order to prevent nose slice departures.

HALF OR FULL FLAP CONFIGURATION

Unlike the auto flap configuration, the FCS incorporates a full time AOA feedback in the half or full flap mode. For this reason, longitudinal trim is required when changing AOA and, therefore, airspeed. When the airplane is trimmed to an AOA, it will tend to maintain that AOA and significant stick force is required to fly at another AOA. AOA feedback is increased above 12° AOA. An AOA warning tone comes on at 15° with flaps HALF or 12° with flaps FULL. The throttles are very sensitive in the thrust range used for landing approach. This combined with rapid engine acceleration characteristics makes it easy to overcontrol thrust on the glide slope.

Airplane response to rudder pedal input varies significantly with AOA. Above optimum approach speed light rudder pedal force can generate a large sideslip angle. Below optimum approach speed, response to rudder pedal input is greatly reduced. The pilot must be constantly aware of these characteristics during single-engine approach/waveoff. If the aircraft decelerates to more than 10° to 12° AOA with A MAX-IDLE thrust split, directional control will almost certainly be lost. A slight reduction in AOA should restore directional control. Sideslip response to rudder pedal force is nonlinear. This characteristic is encountered during cross control sideslip maneuvers. Increasing rudder pedal force is required for increased sideslip up to about 9° sideslip. At this point, sideslip will increase with no increase in rudder pedal force. Above 10° sideslip, required rudder pedal force decreases. Avoid use of cross controls and avoid flying in this unstable region. After a crosswind takeoff, make a shallow upwind turn to maintain the ground track down the runway. During crosswind landing, crab into the wind and maintain balanced flight. Take out half the crab just before touchdown. With over 15 knots crosswind, make a flared landing.

Formation flap transitions (cruise to landing or takeoff configuration) can result in a lateral PIO. This tendency is aggravated when the flaps are lowered above 190 knots. Pilot gain also plays a large part in determining the likelihood of a PIO. Pilot gain can best be reduced by increasing lateral separation from the lead airplane. 180 knots is recommend for transition to the landing configuration. Transition from HALF or FULL to AUTO generally poses no problems.

Full lateral stick rolls in the landing configuration will likely cause a large bank angle overshoot.

SPIN RECOVERY MODE (SRM)

Flight characteristics in SRM differ significantly from those of the normal CAS mode. All FCS feedbacks, interconnects, and gain schedules are removed, leaving the FCS in essentially a three axes DEL mode. Because the artificial yaw stability features of CAS are not available in SRM, the directional axis is very loose. The unaugmented directional stability is weak and the nose tends to wander. Significant pilot compensation is required to maintain zero sideslip, balanced flight. Because the lateral control surfaces are not washed out with increasing AOA as they are in CAS, lateral stick can generate excessive yaw. The airplane is very susceptible to nose-slice departure with even small stick deflection.

An aft CG significantly adds to the possibility of an AOA hangup if departure occurs.

CAUTION

To prevent AOA hang-up, do not intentionally operate in the spin recovery mode if the CG is aft of 25% MAC.

OUT–OF–CONTROL (AFTER 7.0 PROM)

The flight control system incorporates a number of features which augment the airplane's natural departure and spin resistance. With the FCS in the CAS mode, very aggressive maneuvering is possible without departure provided the airplane remains within the established flight envelope. AOA or yaw rate excursion, lateral stick deflection, or CG location which exceed those published in the operating limitations section of this manual may significantly degrade the departure/spin resistance provided by the FCS.

DEPARTURES

Departures occur primarily in the form of a nose slice. The airplane's directional stability is less at 40° to 45° AOA than at either higher or lower AOA. Normally, the CAS yaw stability augmentation will prevent departure even in the 40° to 45° AOA region. Departures are most likely when the AOA is stabilized in the 40° to 45° range, with a high load factor, and at high speed (high energy). The airplane is more departure prone at lower altitudes. High lateral asymmetry significantly reduces departure resistance above 20° AOA. Normally, asymmetric thrust, including one engine in maximum afterburner and the other at idle or flamed–out, will not in itself, cause a departure, However, asymmetric thrust combined with aggravating flight controls may cause a directional nose slice departure under normally benign conditions. Lower altitudes will aggravate asymmetric thrust effects due to the larger thrust differential.

Departures are characterized by a yaw divergence (nose slice) followed by an uncommanded roll in the same direction as the initial yaw. The initial phase of a nose slice departure is not particularly violent or disorienting compared to other tactical jet airplanes. Directional departures initiated from low (1–2) G at high altitude are characterized by low to moderate initial yaw rates and very low cockpit side forces. For this reason, a pilot may not perceive an out–of–control situation for a number of seconds after the actual departure commences. If an asymmetric load exists at departure, the airplane will tend to yaw and roll away from the heavy wing.

Neutral controls and symmetric thrust (throttles at IDLE) are effective in regaining control following departure. If the airplane does not respond to neutral controls after allowing a few seconds for post–stall gyrations to cease, it has most likely entered the low yaw rate spin mode or an AOA hangup and further pilot action may be required to effect a recovery.

TF/A–18 Characteristics

The larger canopy of the TF/A–18 appears to reduce the excellent departure resistance that is characteristic of the single seat airplane. Other factors that increase the possibility of departure are (1) carriage of a centerline fuel tank and (2) any asymmetric store loading. Departures have occurred with a centerline tank and an asymmetric load of 2500 foot–pounds at an AOA of 30°.

SPINS

Three more or less distinct spin modes (all upright) have been observed and an inverted flight spin mode is predicted from wind tunnel and simulator data. The airplane is very reluctant to enter any spin with the CAS operating and within the flight limitations contained in this manual.

LOW YAW RATE MODE

The low yaw rate spin mode is characterized by AOA in the 50° to 60° range and a very low yaw rate (0° to 40°/second). This mode can be very smooth, although some mild pitch, roll, and yaw motions are normally experienced. The low rate spin is not normally violent or disorienting and cockpit forces are low. Low cockpit forces and low yaw rate make this mode difficult to recognize as a spin. Rate of descent for an established low yaw rate spin is approximately 20,000 feet/minute. As much as 5000 feet may be lost per turn. Entry to the low yaw rate spin mode can occur when operating between 50° and 60° AOA; however, the yawing moment necessary for entry is difficult to generate in this AOA range. A low yaw rate spin entry is much more likely when large sustained lateral and/or directional controls are applied at lower AOA. Excessive yaw rate under these conditions can inertially couple into the pitch axis and generate AOA overshoot into or beyond the 50° to 60° range. Asymmetric thrust and/or asymmetric store loadings significantly reduce the airplane's resistance to the low yaw rate spin.

Intermediate Yaw Rate Mode

The intermediate yaw rate spin mode is characterized by higher average yaw rates than the low yaw rate mode (20° to 80°/second). This mode is very oscillatory in pitch and roll. AOA will vary between 40° to 80° and bank angles between 60° left and right. Bank angle variations may increase to the point where the airplane will execute one or more 360° rolls while continuing to spin in the same direction. Rate of descent is about 21,000 feet/minute. Altitude loss per turn is about 1500 feet. Cockpit sideforce can be as high as 1 G left or right. The airplane will unload (negative G) during 360° rolls. Due to the highly oscillatory nature and the rapid variations in cockpit forces, this spin mode can be very disorienting. The pilot will probably experience difficulty in determining spin direction from visual cues outside the cockpit. Disorientation may be aggravated if the pilot is not securely strapped in. Entry into an intermediate yaw rate spin is unlikely in clean configuration and more likely with high asymmetric store loading.

High Yaw Rate Mode

The high yaw rate spin mode is characterized by yaw rates in the 100° to 140°/second range and AOA of 80° to 90°. This mode is best described as a smooth flat spin. Small oscillations in pitch and roll have been observed but are not generally perceived by the pilot. Longitudinal forces in the cockpit can be as high as -3.5 G (eyeballs out). Consequently, the pilot will be significantly hindered in recovery unless his shoulder harness is manually locked. Because this mode is smooth and flat, the pilot should experience no difficulty in determining spin type or direction. Rate of descent for an established high yaw rate spin averages 18,000 feet/minute (1000–1500 feet/turn). Entry into this mode is possible only with sustained (more than 15 seconds) full pro-spin lateral stick with the FCS in the spin recovery mode. Pro-spin controls are not available with full lateral stick in the spin recovery mode.

Spin Recovery

Spin recovery characteristics from any mode with the FCS in the CAS mode are very poor due to the reduced differential stabilator and aileron authority at higher AOA. With the FCS in the spin recovery mode (SRM), spin recovery characteristics are excellent. The command arrow on the DDI indicates the correct stick position for recovery from either an upright or inverted spin. In the SRM, application of lateral stick in the direction of the command arrow on the DDI will cause a rapid reduction of yaw rate. After the yaw rate is stopped (arrow on DDI disappears) forward stick may be required to reduce the AOA below 45°. It may be impossible to reduce the AOA before the yaw rate is completely stopped due to inertia coupling especially with an aft CG. Recovery from the high yaw rate spin mode can be made within 2½ turns. Lower yaw rate modes require a correspondingly lesser number of turns for recovery. Approximately 12,000–14,000 feet are required to effect recovery from a fully developed spin (from application of recovery controls to dive pull-out).

AOA HANGUP

The airplane exhibits a weak nose-down pitching moment in the 45° to 55° AOA region. This characteristic is significantly aggravated with an aft CG and some external store loadings. Three external fuel tanks appear to be the most destabilizing. AOA hangup is characterized by AOA stabilization near 50° and lack of response to forward stick. With a slightly forward CG, the AOA will respond to longitudinal stick but the response is very sluggish. As much as 15 seconds may be required to reduce the AOA below 35°. With the CG further forward, the likelihood of an AOA hangup is reduced proportionally and pitch response is more positive. Lateral-directional oscillations, perceived as wing rock by the pilot, will aggravate the AOA hangup and the hangup may occur at a CG as much as 4% MAC further forward than it would occur without wing rock. Certain store loadings (centerline tank) may contribute to onset of lateral-directional oscillations. AOA hangup occurs most often during the final portion of a spin recovery after the yaw rate stopped and from departures at near zero airspeed (vertical manuevers). AOA hangup has also occurred following a nose-slice departure and during a very smooth approach to a 1 G stall. Recovery from AOA hangup can best be made by neutralizing controls if the FCS is in CAS (the AOA feedback will drive the stabilators full nose down) or by full forward stick if the FCS is in the SRM mode. Extraordinary patience is required since AOA response, in the worst case, may be very slow. If the airplane rolls inverted and stabilizes, aft stick will be required for recovery.

CG EFFECTS

Above 20° AOA, response to nose-down commands degrades as the CG moves aft of 24% MAC. At low fuel states, use care to avoid exceeding AOA or acceleration limits. Refer to Landing With Aft CG, section V.

FLIGHT CHARACTERISTICS WITH EXTERNAL STORES (AFTER 7.0 PROM)

Handling qualities with wing stores are satisfactory so long as the flight control system is operating normally (full CAS) and AOA, CG, and asymmetric store loading restrictions are complied with.

ASYMMETRIC STORES

Flight characterics with asymmetric stores up to 12,000 foot-pounds moment are satisfactory. However, departure resistance is decreased in the TF/A-18 with a centerline tank with any asymmetric store.

CAUTION

- Avoid aggressive roll maneuvers below 225 knots with asymmetric external load.
- Nose slice departure into the light wing is likely when maneuvering above 30° AOA with asymmetry near or above 6000 foot-pounds.
- Nose slice departure is likely when maneuvering above 20° AOA in TF/A-18 airplanes with centerline tank below 6000 foot-pounds lateral asymmetry.

CG DETERMINATION (ALL AIRPLANES)

The airplane CG can be approximated within ±0.5% MAC based on tank 1 and tank 4 fuel quantities, ammo, and external store loading. Figure 4-1 provides the CG for a clean F/A-18 when entered with tank 1 and tank 4 fuel quantities providing feed tanks are near full. Figure 4-2 provides the same data for a clean TF/A-18. Figure 4-3 provides correction data for ammo, missiles, and other external stores which are loaded on the airplane. When these corrections are added algebraically to the CG determined from figure 4–1 or 4–2, the sum is the airplane CG at that tank 1/tank 4 fuel quantity if the feed tanks are near full. As feed tank fuel is used, the CG will continue to move aft and will have moved about 1.7% MAC further aft when feed tank fuel reaches 1500 pounds.

Figures 4–4 thru 4–7 are CG travel due to fuel consumption charts from which figures 4–1 and 4–2 were derived. Figures 4–4 and 4–5 also show the approximate area where the CG caution is on. Figures 4–1 and 4–2 are valid only in those areas on 4–4 thru 4–7 that fall within the tank 1/tank 4 grid. Note, on the lower right corner of this grid, the continuing line which shows further aft CG travel as feed tank fuel is used. Figure 4–4 also shows the effect of a tank 4 transfer failure at 2000 pounds fuel remaining in tank 4. The dashed line shows the CG travel after tank 1 is depleted with tank 4 remaining at 2000 pounds.

C G vs Tanks 1 & 4 Fuel - F/A-18A

TANK 1									
	2800	18.8	19.3	19.8	20.3	20.9	21.4	21.9	22.5
	2500	19.5	20.0	20.6	21.1	21.6	22.1	22.6	23.2
	2000	20.7	21.2	21.8	22.3	22.8	23.3	23.8	24.4
	1500	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.6
	1000	23.3	23.8	24.2	24.8	25.2	25.7	26.2	26.8
	500	24.5	25.0	25.5	26.0	26.4	26.9	27.4	28.0
	0	25.8	26.3	26.7	27.2	27.6	28.1	28.6	29.1
		0	500	1000	1500	2000	2500	3000	3600
		TANK 4							

18AC–NFM–00–(121)

Figure 4–1. CG vs Tanks 1 & 4 Fuel – F/A–18A

C G vs Tanks 1 & 4 Fuel - TF/A-18A

TANK 1									
	2100	19.8	20.3	20.8	21.3	21.8	22.3	22.8	23.4
	1500	21.3	21.7	22.3	22.7	23.2	23.7	24.2	24.7
	1000	22.6	23.0	23.5	23.9	24.3	24.8	25.3	25.8
	500	23.9	24.3	24.7	25.1	25.5	26.0	26.4	26.9
	0	25.0	25.4	25.8	26.2	26.7	27.1	27.5	28.0
		0	500	1000	1500	2000	2500	3000	3600
		TANK 4							

18AC–NFM–00–(120)

Figure 4–2. CG vs Tanks 1 & 4 Fuel – TF/A–18A

C G Correction For Stores/Ordnance

STORES	C G CHANGE % MAC		
AIM–9 (STA 1 OR 9) AIM–7 (STA 4 OR 6)	0.2 EACH 0.5 EACH		
	LOADED		SPENT
400 RDS 570 RDS	–1.4 –2.0		–0.6 –0.9
	STA 5	STA 2 AND 8 (TOTAL)	STA 3 AND 7 (TOTAL)
PYLON	–0.2	0.2	0.2
MER–7	N/A	N/A	–0.1
VER	–0.2	–0.1	–0.1
FUEL TANK (EMPTY)	–0.3	N/A	0.0
1000 POUNDS	–1.2	–0.1	–0.2
2000 POUNDS	–2.4	–0.2	–0.4

18AC–NFM–00–(122)

Figure 4–3. CG Correction For Stores/Ordnance

C G Travel Due to Fuel Consumption

F/A-18A 161520 AND UP

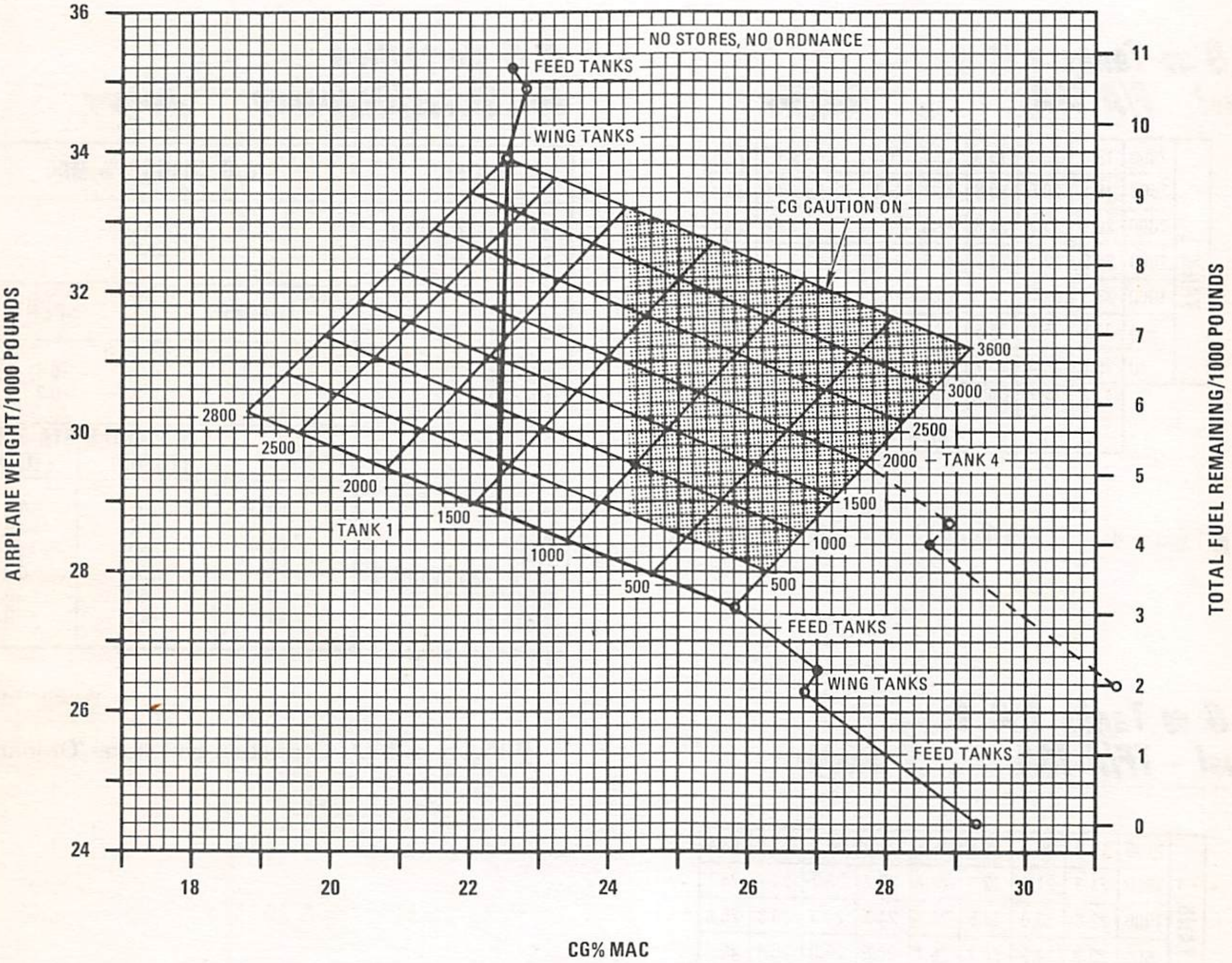

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Figure 4–4. CG Travel Due To Fuel Consumption – F/A–18A 161520 and up

C G Travel Due to Fuel Consumption

TF/A-18 161704 AND UP

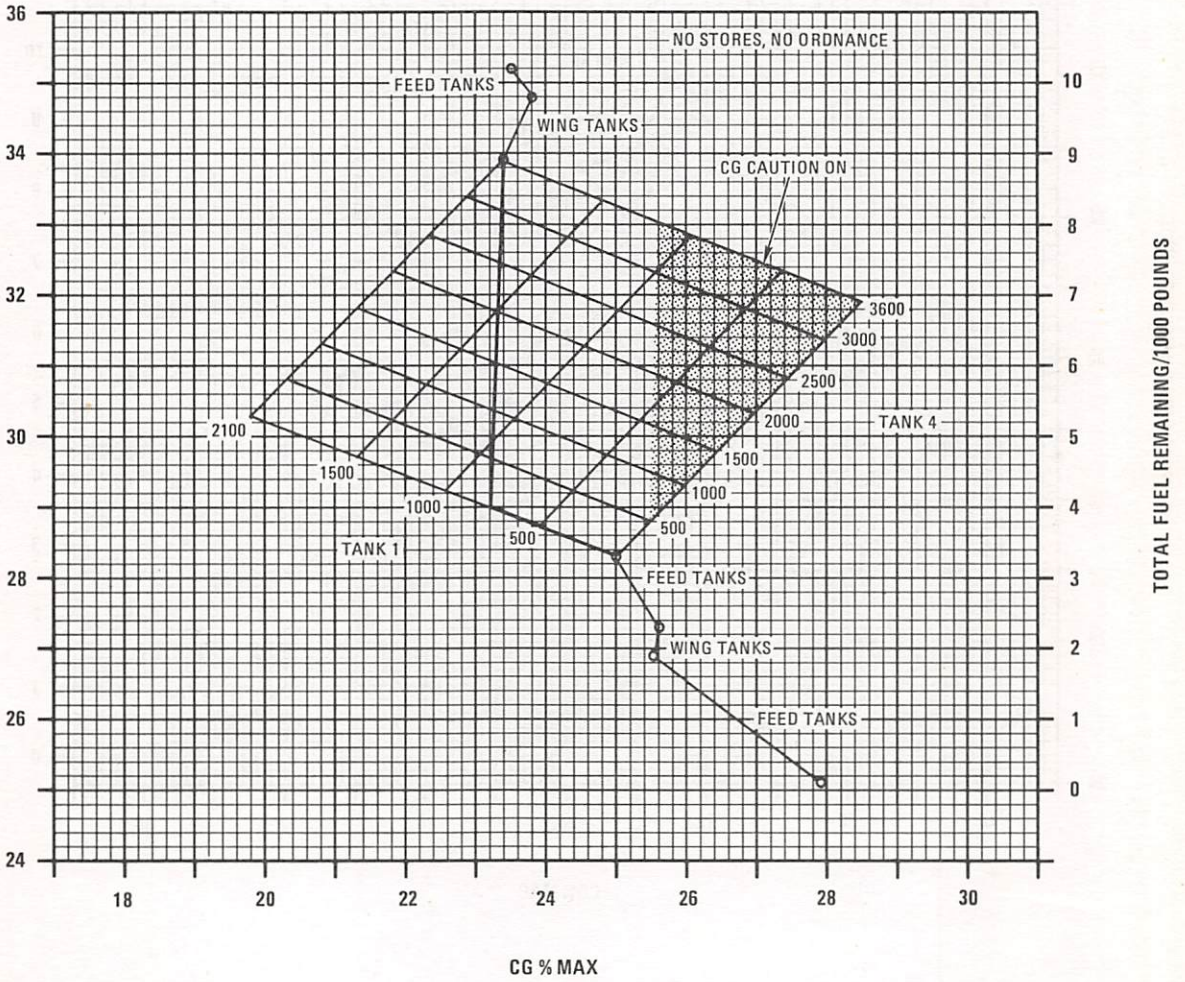

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Figure 4-5. CG Travel Due To Fuel Consumption - TF/A-18A 161704 and up

C G Travel Due to Fuel Consumption

F/A-18A 161353 THRU 161519

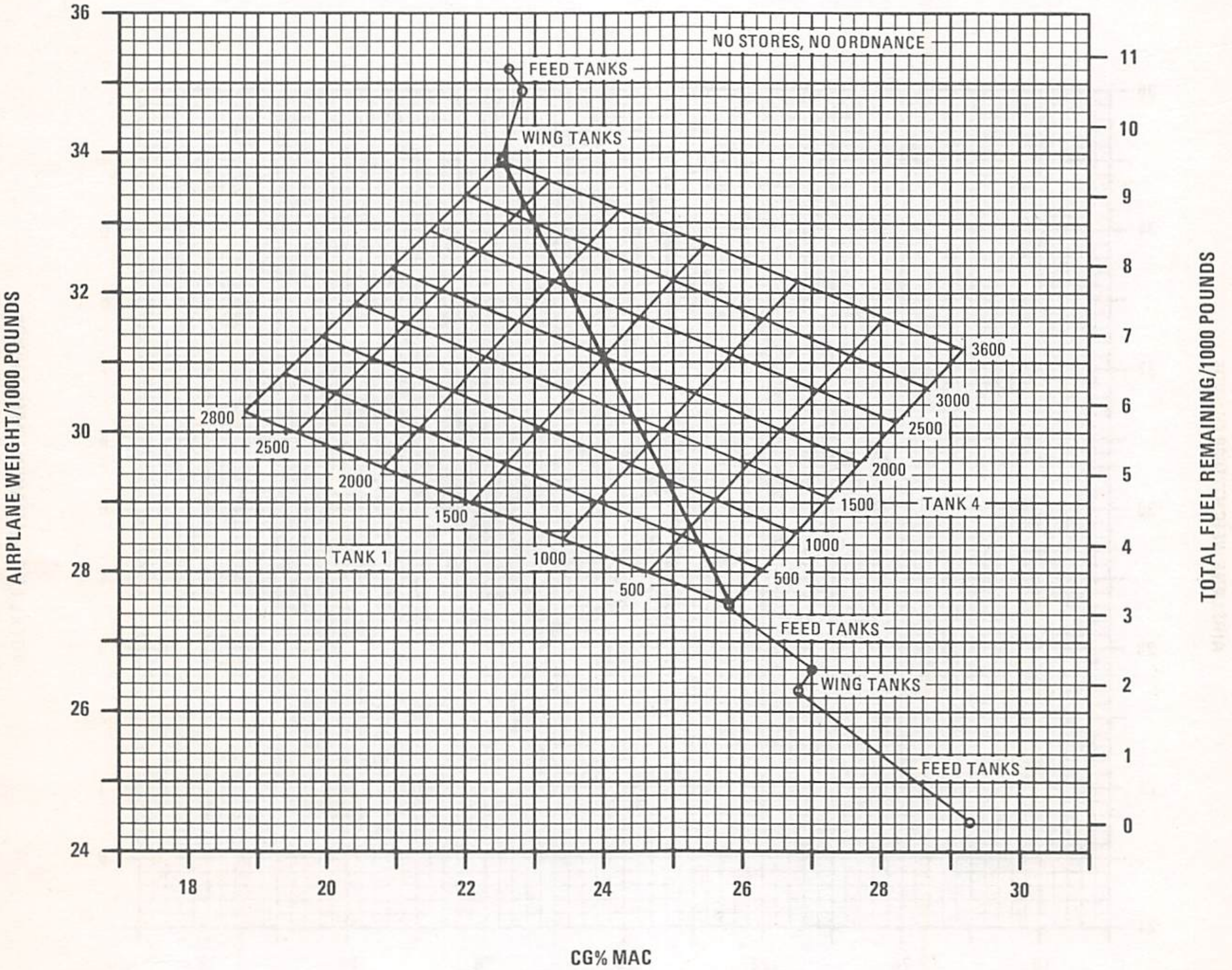

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Figure 4-6. CG Travel Due To Fuel Consumption – F/A–18A 161353 thru 161519

C G Travel Due to Fuel Consumption

TF/A-18 161354 THRU 161360

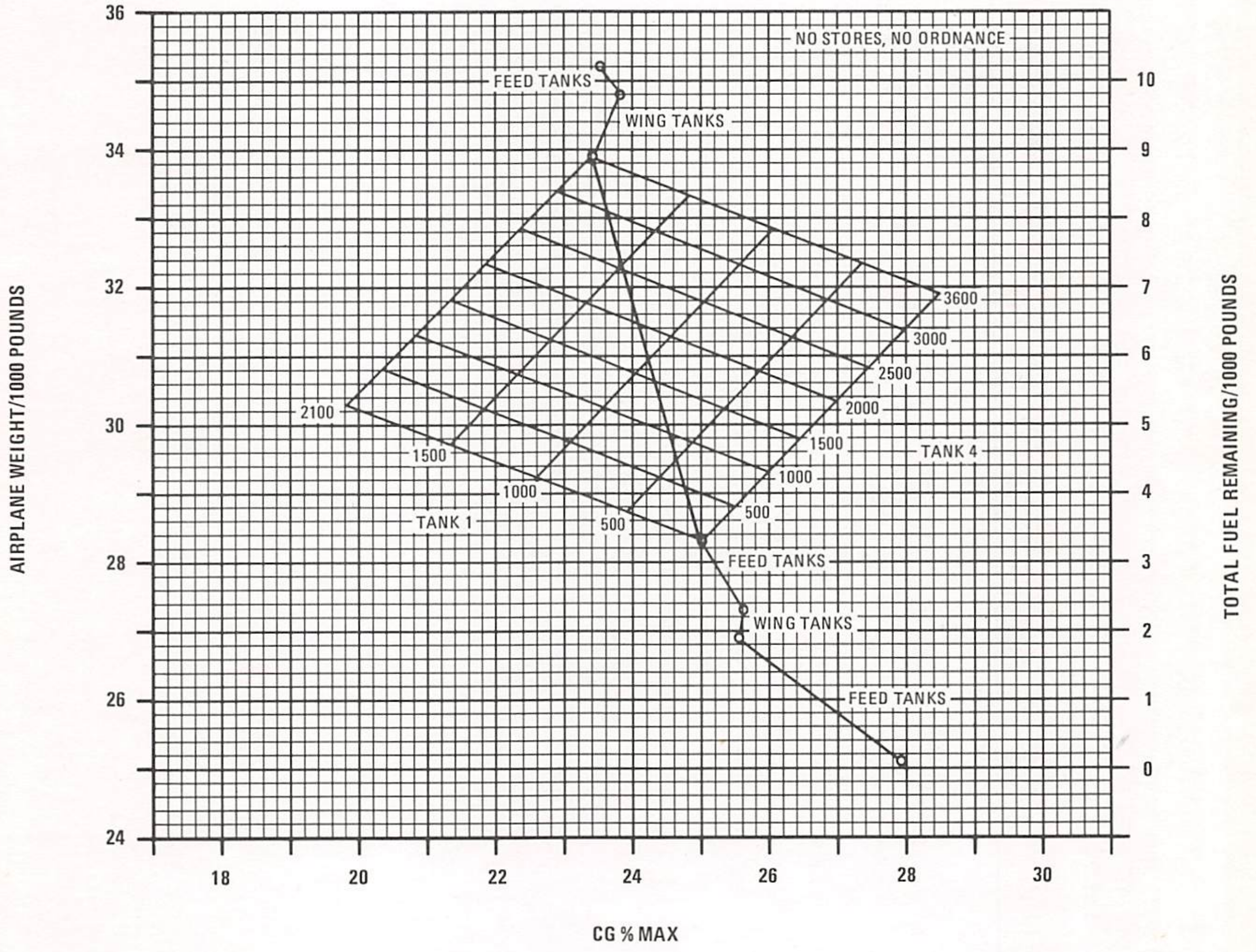

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Figure 4–7. CG Travel Due To Fuel Consumption – TF/A–18A 161354 thru 161360

SECTION V

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GENERAL

This section contains procedures to correct an abnormal or emergency condition. Modify these procedures as required in case of multiple emergencies, adverse weather or other peculiar factors. Use common sense and sound judgement to determine the correct course of action. Apply the following rules to all emergencies:

1. Maintain aircraft control
2. Analyze the situation and take proper action
3. Land as soon as practical

Do only those steps required to manage the problem. When operating a control, be prepared to immediately return the control to its former setting if an undesirable response occurs. As soon as possible, notify the flight leader, ship, ATC, tower, etc., as applicable, of your emergency, position, and intended action. Broadcast all emergency indications, airspeed, altitude, heading, power setting, etc., as time permits.

IMMEDIATE ACTION ITEMS

Procedural steps preceded by an asterisk (*) are considered immediate action items. Pilots should be able to accomplish these steps without reference to the checklist.

WARNING/CAUTION/ADVISORY DISPLAYS

The warning, caution, and advisory displays are listed in figure 5–1 together with the cause and corrective action. They are listed under five major headings:

a. Warning Lights
b. Cautions
c. FCS Cautions (5.3.1 PROM)
d. FCS Cautions (after 7.0 PROM)
e. Advisories

Each display is listed alphabetically under its major heading; however, if the display starts with a single letter, for example L, R, P, or Y, that letter is not used to place the display alphabetically. Emergency procedures associated with a warning or caution display are shown in this figure and are not repeated elsewhere in this manual.

Warning/Caution/Advisory Displays

✱ Immediate action item
★ Discussion in section V

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
	WARNING LIGHTS	
APU FIRE	APU fire detected	In flight or on ground - ✱ 1. APU Fire light - PUSH ✱ 2. Fire extinguisher READY light - PUSH On ground - ✱ 3. Throttles - OFF ✱ 4. Egress
L BAR	Ground (5.3.1. PROM) Both throttles at MIL and launch bar switch EXTEND Ground (After 7.0 PROM) Launch bar malfunction Inflight (all airplanes) Launch bar not locked up ● Nose Gear will not retract ★ Refer to Launch Bar Malfunction	After both throttles at MIL - 1. Launch bar switch - RETRACT If light still on - 2. Suspend catapult launch If light on after takeoff - 1. Gear - LEAVE DOWN IF PRACTICAL 2. Launch bar switch - RETRACT 3. Launch bar circuit breaker - PULL
L BLEED R BLEED	Bleed air leak detected on designated side ● With both lights on - NO ECS No external fuel transfer	1. Bleed air switch - OFF (affected engine) 2. Land as soon as practical
FIRE	Engine fire detected ★ Refer to Engine Fire On Takeoff or Engine Fire In Flight	GROUND ✱ 1. L or R FIRE light - PUSH ✱ 2. Fire Extinguisher READY light - PUSH ✱ 3. Throttles - OFF ✱ 4. Egress ON TAKEOFF If decision to stop is made - ✱ 1. Abort If takeoff is continued - ✱ 1. Throttles - MIL or MAX ✱ 2. Maintain ON-SPEED AOA and balanced flight ✱ 3. External stores - JETTISON (if required) INFLIGHT ✱ 1. Confirm fire ✱ 2. L or R FIRE light - PUSH ✱ 3. Fire extinguisher READY light - PUSH When rpm decreases - 4. Throttle - OFF
GEAR HANDLE	Landing gear in transit, unsafe, or planing link failure (with flashing gear position light)	STEADY - 1. Check gear down indicators
	Below 7500 feet and below 175 knots and over 250 feet per minute descent. ★ Refer to Landing Gear Unsafe/Fails to Extend	FLASHING - 1. Gear - DOWN or 2. Increase airspeed or altitude
HOOK	Hook in transit	If hook will not extend - 1. Hook circuit breaker - PULL
RADAR ALT LOW LIGHT	Altitude below preset radar altitude	Information
THREAT WARNINGS	Refer to A1-F18AC-TAC-100.	
UNSFE (aft cockpit)	Landing gear in transit	Information

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Figure 5–1. Warning/Caution/Advisory Displays (Sheet 1 of 11)

Warning/Caution/Advisory Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
	CAUTIONS	
L AMAD R AMAD	AMAD oil temperature too high ★Refer to AMAD Caution	INFLIGHT 1. Throttle - IDLE 2. Wing fuel transfer switch - NORM 3. MENU ENG - CHECK FUEL TEMP If generator drops off line - 4. Shut down engine, restart for landing 5. Land as soon as practical GROUND 1. Shut down engine when practical
L AMAD PR R AMAD PR	Loss of designated AMAD oil ★ Refer to AMAD PR Caution	1. Generator - OFF If more than 30 minutes to landing - 2. Shutdown engine, restart for landing
ANTI SKID	Anti-skid inoperative ● Use caution during braking	1. Anti-skid switch - CYCLE If caution still on - 2. Anti-skid switch - OFF
APU ACCUM	APU accumulator pressure low ● Possible leak in isolated HYD 2B system	1. HYD ISOL ORIDE (5 seconds maximum) If caution still on or comes on again - 2. Extend landing gear as soon as practical
L ATS R ATS	Designated air turbine starter rpm too high	After engine start (other than momentary) - 1. Shut down engine In flight - 1. Throttle - IDLE 2. Land as soon as practical
AV AIR HOT	Avionics cooling air hot or low flow. ● Prolonged caution may result in loss of MC1, MC2, INS, HUD, DDI, etc. ● If bleed air off, see remarks under L BLEED OFF/R BLEED OFF remarks	INFLIGHT 1. Bleed air knob - CYCLE 2. ECS mode switch - MANUAL If caution on after 1 minute - 3. ECS mode switch - OFF/RAM 4. Airspeed - SUBSONIC 5. Unneeded avionics - OFF If caution still on after another minute - 6. Consider bleed air knob - OFF GROUND 1. Either throttle - ADVANCE Or - 1. Bleed air knob - AUG PULL 2. APU - START
E BATT LO U BATT LO	Emergency battery and/or utility battery charge low	INFLIGHT 1. Avoid high speed 2. Battery switch - OFF/ON FOR LANDING
BATT SW	Battery switch ON without ac power on airplane Battery switch OFF with ac power on airplane ● Prolonged ground operation with caution on may damage battery and dc electrical system	If ac power on & battery switch OFF or ORIDE - 1. Battery switch - ON If no internal dc power & battery switch ON or ORIDE - 2. Refer to Double Generator Or Double Transformer - Rectifier Failure

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Figure 5-1. Warning/Caution/Advisory Displays (Sheet 2)

Warning/Caution/Advisory Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
	CAUTIONS	
BINGO	Fuel below bingo bug setting	Information
L BLEED OFF R BLEED OFF	Designated bleed air shut off valves closed If both bleed air lights on - ● No crossbleed start ● No ECS or pressurization ● No external tank transfer ● No throttle boost ● No windshield anti-ice/rain removal ● May get AV AIR HOT during approach	If bleed air shut off automatically - 1. Bleed air knob - CYCLE
L BOOST LO R BOOST LO	No designated AMAD pump engine feed pressure ● Crossfeed opens automatically ● May indicate fuel transfer failure ● Afterburner may not operate above 30,000 feet	1. Monitor fuel transfer and temperature 2. Land as soon as practical
BRK ACCUM	Brake accumulator pressure low ● Possible leak in isolated HYD 2B system	1. Extend landing gear as soon as practical
CANOPY	Canopy unlocked ● In TF, rear seat occupant should lower seat and lean as far forward as possible	INFLIGHT 1. Slow below 300 (200 in TF) if practical 2. Descend 3. Canopy switch - DOWN If light stays on - 4. Land as soon as practical
CAUT DEGD	Caution indications degraded ● Cautions may be false or erratic	1. MC 1 - CYCLE 2. Land as soon as practical
CG	Tanks 1 and 4 fuel distribution out of balance	1. Stop maneuvering 2. Check transfer tanks 1 & 4 3. Calculate CG If CG aft of limit - 4. Refer to Landing With Aft CG
CNI	CNI interface failure ● UFC may not operate in some or all modes	Informaton
DISCH	Fire extinguisher discharge initiated	Information
L DUCT DR R DUCT DR	Designated duct door closed above Mach 1.33 or open below Mach 1.23 ● Drag is increased with door open	1. Reduce speed below Mach 1.23
DUMP OPEN	Fuel dump valve open with OFF selected.	1. Fuel dump switch - CYCLE

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Figure 5–1. Warning/Caution/Advisory Displays (Sheet 3)

Warning/Caution/Advisory Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
	CAUTIONS	
L EGT HIGH R EGT HIGH	Designated exhaust gas temperature out of limits	*1. Throttle - IDLE 2. MENU ENG - CHECK EGT If EGT high at IDLE - 3. Throttle - OFF
EXT TANK	External tanks pressurized on deck	GROUND 1. Do not catapult
L FLAMEOUT R FLAMEOUT	Designated engine flamed out ★ Refer to Engine Failure	GROUND 1. Abort INFLIGHT 1. Refer to Airstart
L FUEL HOT R FUEL HOT	Designated engine fuel feed temperature too high	1. Fuel flow - INCREASE (if practical) 2. Wing fuel switch - CHECK NORM 3. MENU ENG - MONITOR FUEL TEMP
FUEL LO	At least one feed tank below 800 pounds ● No negative G ● Sideslip may be required to transfer wing fuel	1. Fuel flow - REDUCE (if practical) 2. Refer to Fuel Transfer Failures
L GEN R GEN	Designated generator off line ● Either Generator can support the total airplane electrical load	1. Generator switch - CYCLE If generator still failed - 2. Generator switch - OFF 3. Land as soon as practical
GUN GAS	Gun purge air pressure low	1. Do not fire gun
HYD 1A HYD 1B	Designated hydraulic system pressure low ● No effect on systems operation for single failure	1. Refer to Hydraulic Flow Diagram
HYD 2A	HYD 2A system pressure low	1. Refer to Hydraulic Failures
HYD 2B	HYD 2B system pressure low	1. Extend landing gear as soon as practical 2. Refer to Hydraulic Failures
IFF 4	Mode 4 OFF, ZEROIZED, not responding	Information
L IN TEMP R IN TEMP	Designated engine inlet temperature out of limits	GROUND 1. Abort INFLIGHT *1. Throttle - IDLE 2. Land as soon as practical
INLET ICE	Engine inlet icing conditions detected	1. Engine anti-ice switch - ON
INS ATT	HUD attitude supplied by the standby attitude indicator ● W replaces -o- on HUD	1. ATTD select switch - STBY

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Figure 5-1. Warning/Caution/Advisory Displays (Sheet 4)

Warning/Caution/Advisory Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
CAUTIONS		
LADDER	Boarding ladder unlocked ● May FOD left engine	INFLIGHT 1. Get visual check if practical 2. Land as soon as practical
MC 1	Mission computer 1 failed ● Most DDI cautions lost	1. Cycle switch 2. Land as soon as practical
MC 2	Mission computer 2 failed	1. Cycle switch
L OIL PR R OIL PR	Designated engine oil pressure out of limits	* 1. Throttle - IDLE If caution still on - 2. Throttle - OFF (if practical)
L OVRSPD R OVRSPD	Designate fan or compressor rpm high	* 1. Throttle - IDLE 2. MENU ENG - MONITOR RPM If 109% N_1 or 104% N_2 rpm exceeded - 3. Throttle - OFF (if practical)
OXY LOW	Oxygen quantity indication below 1 liter or pressure low	1. Oxygen quantity - Check If over 1 liter - 2. Maintain cabin altitude below 10,000 feet
PARK BRAKE	INS ON, throttles over 80%, and parking brake set	1. Parking brake - CHECK
L PITOT HT R PITOT HT	Designated pitot heater malfunction	1. Pitot heat switch - CYCLE
PROBE UNLK	Air refueling probe not fully retracted with switch in RETRACT	1. Slow below 300 knots 2. Probe switch - CYCLE
TANK PRESS	GROUND - Internal fuel tank pressure high ● Catapult may cause structural damage	GROUND 1. Bleed air switch - OFF 2. Abort
	INFLIGHT - Internal fuel tank pressure low ● Possible fuel pump cavitation above 40,000 feet	INFLIGHT 1. Bleed air switches - CYCLE 2. Do not exceed 0.9 Mach in dive
WDSHLD HOT	Windshield temperature high or sensor failed	1. Anti-ice/rain removal switches - OFF 2. Power - REDUCE If caution remains; consider - 1. Bleed air switch - OFF 2. Land as soon as practical
WING UNLK	Either wingfold unlocked	GROUND 1. Do not launch INFLIGHT 1. Land as soon as practical

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Figure 5-1. Warning/Caution/Advisory Displays (Sheet 5)

Warning/Caution/Advisory Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
FCS CAUTIONS (5.3.1 PROM)		
P DEL ON R DEL ON Y DEL ON	Pitch (P), roll (R), or yaw (Y) axis has reverted from CAS to DEL mode ★ Refer to DEL Cautions (5.3.1 PROM)	If P DEL on - 1. Do not extend speedbrake 2. Flaps - HALF FOR LANDING 3. Do not exceed 7° AOA for landing If Y DEL and/or R DEL on - 1. Do not pump rudder pedals 2. Do not use more than ½ rudder in flight 3. Flaps - HALF FOR LANDING 4. Do not exceed 7° AOA for landing
FCES	Third like failure or flight control function lost ● Caution light backup for DDI FCS cautions ★ Refer to FCS Failure	1. Maintain 200-300 knots, minimum sideslip, AOA < 10°, 2 G maximum 2. MENU FCS - IDENTIFY FAILURE 3. FCS - RESET If no reset - 4. FCS circuit breakers - CHECK 5. Refer to FCS Failure Indications and Effects 6. If CG aft of 24% or lateral asymmetry over 12,000 foot-pounds, jettison external stores as soon as practical 7. Make controllability check 8. Land as soon as practical
FCS	One or more failures in flight controls ★ Refer to FCS Failure	1. MENU FCS - IDENTIFY FAILURE 2. FCS - RESET
FCS HOT	Flight control computer A or right transformer- rectifier overtemperature ● FCS air scoop cannot be closed in flight	1. Airspeed - SUBSONIC 2. FCS cool switch - EMERG
FCS 1ST	Single failure in FCS system	1. MENU FCS - IDENTIFY FAILURE 2. FCS - RESET
FCS 2ND	Second failure in FCS system ● One more failure will cause loss of an FCS function ★ Refer to FCS Failure	1. Maintain 200-300 knots, minimum sideslip, AOA < 10°, 2 G maximum 2. MENU FCS - IDENTIFY FAILURE 3. FCS - RESET If no reset - 4. FCS circuit breakers - CHECK 5. Refer to FCS Failure Indications and Effects 6. If CG aft of 24% or lateral asymmetry over 12,000 foot-pounds, jettison external stores as soon as practical 7. Make controllability check 8. Land as soon as practical
FLAPS OFF	Leading and/or trailing edge flaps inoperative ★ Refer to FLAPS OFF Caution	If leading edge flaps failed - 1. Do not exceed 10° AOA with flaps AUTO 2. Make controllability check at safe altitude 3. Flaps - HALF FOR LANDING (12° AOA permitted only to slow to 200 knots) 4. If LEF extension less than 10°, do not exceed 7° AOA for landing If trailing edge flaps failed - 1. Make controllability check for safe altitude 2. Flaps - HALF OR FULL FOR LANDING 3. Use 10°-11° AOA for landing, if required

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Figure 5–1. Warning/Caution/Advisory Displays (Sheet 6)

Warning/Caution/Advisory Displays

FCS CAUTIONS (5.3.1 PROM)

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
FX GAINS	Flight controls in fixed gains mode ★ Refer to FX GAIN Caution ● AUTO flaps inoperative ● For landing, use flap setting which provides best handling qualities	1. Maintain 200-300 knots minimum sideslip AOA < 10°, 2 G maximum 2. Flaps - HALF OR FULL (200 knots straight and level)
MECH ON	Stabilator has reverted to mechanical control ★ Refer to MECH ON Caution	1. Wing stores - JETTISON 2. Make controllability check at safe altitude 3. Do not exceed 7° AOA 4. Flaps - HALF FOR LANDING 5. Do not exceed 200 knots with flaps HALF 6. If flying qualities permit, arrested landing recommended
NO LIMITER	Roll rate limiting failed ● Roll sensitivity increased	1. Use no more than ½ stick with roll limited stores aboard
NWS	Nosewheel steering inoperative	Information
R OFF	Ailerons inoperative ● Roll control with differential stabilators	1. Flaps - HALF FOR LANDING 2. Fly ON - SPEED AOA
Y OFF	Rudders inoperative - ● Ailerons switch to DEL ★ Refer to Y OFF Caution	1. Use differential throttle for yaw control

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Figure 5-1. Warning/Caution/Advisory Displays (Sheet 7)

Warning/Caution/Advisory Displays

FCS CAUTIONS (AFTER 7.0 PROM)

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
AIL OFF	Either aileron off	1. Flaps - HALF FOR LANDING 2. Fly ON - SPEED AOA
AUTO PILOT	Uncommanded auto pilot disengage	1. Assume control
DEL ON	Any axis in DEL ★ Refer to DEL ON Caution	If pitch axis in DEL - 1. Do not extend speedbrake 2. Flaps - HALF FOR LANDING 3. Do not exceed 7° AOA for landing If yaw and/or roll axis in DEL - 1. Do not pump rudder pedals 2. Do not use more than ½ rudder in flight 3. Flaps - HALF FOR LANDING 4. Do not exceed 7° AOA for landing
FC AIR DAT	L & R air data probes disagree ● Use flap setting which provides best handling quantities. ★ Refer to FC AIR DAT Caution	1. Maintain 200-300 knots, minimum sideslip, AOA < 10° maximum 2 G 2. Flaps - HALF OR FULL (200 knots straight and level) 3. Gain switch - ORIDE
FCES	Third like failure or flight control function lost ● Caution light backup for DDI FCS cautions ★ Refer to FCS Failure	1. Maintain 200-300 knots, minimum sideslip, AOA < 10° 2 G maximum 2. MENU FCS - IDENTIFY FAILURE 3. FCS - RESET If no reset and second failure exists - 4. FCS circuit breakers - CHECK 5. Refer to FCS Failure Indications And Effects 6. If CG aft of 24% or lateral asymmetry over 12,000 foot-pounds, jettison external stores as soon as practical 7. Make controllability check 8. Land as soon as practical
FCS	One or more failures in flight controls ★ Refer to FCS Failure	1. MENU FCS - IDENTIFY FAILURE 2. FCS - RESET If no reset and second failure exists - 3. Maintain 200-300 knots, minimum sideslip, AOA < 10° 2 G maximum 4. FCS circuit breakers - CHECK 5. Refer to FCS Failure Indications And Effects 6. If CG aft of 24% or lateral asymmetry over 12,000 foot-pounds, jettison external stores as soon as practical 7. Make controllability check 8. Land as soon as practical
FCS HOT	Flight control computer A or right transformer - rectifier overtemperature ● FCS airscoop cannot be closed in flight	1. Airspeed - SUBSONIC 2. FCS cool switch - EMERG

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Figure 5-1. Warning/Caution/Advisory Displays (Sheet 8)

Warning/Caution/Advisory Displays

FCS CAUTIONS (AFTER 7.0 PROM)

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
FLAPS OFF	Leading and/or trailing edge flaps inoperative ★Refer to FLAPS OFF Caution	If leading edge flaps failed - 1. Do not exceed 10° AOA with flaps AUTO 2. Make controllability check at safe altitude 3. Flaps - HALF FOR LANDING 4. If LEF extension less than 10°, do not exceed 7° AOA for landing If trailing edge flaps failed - 1. Make controllability check at safe altitude 2. Flaps - HALF OR FULL FOR LANDING 3. Use 10°-11° AOA for landing, if required
FLAP SCHED	Flaps frozen and not scheduling properly (AOA or air data) or leading edge flap at least 10° off schedule and AOA over 12°	1. Reduce AOA If handling qualities require - 2. Gain switch - ORIDE BELOW 350 KNOTS For landing - 3. Flaps - FULL AT 200 KNOTS
MECH ON	Stabilator has reverted to mechanical control ★Refer to MECH ON Caution	1. Wing stores - JETTISON 2. Make controllability check at safe altitude 3. Do not exceed 7° AOA 4. Flaps - HALF FOR LANDING 5. Do not exceed 200 knots with flaps HALF 6. If flying qualities permit, arrested landing recommended
NO LIMITER	Roll rate limiting failed ● Roll sensitivity increased	1. Use no more than ½ stick with roll limited stores aboard
NWS	Nosewheel steering inoperative	Information
RUD OFF	One or both rudders inoperative ★Refer to RUD OFF Caution	If both rudders failed - 1. Use differential throttle for yaw control

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Figure 5-1. Warning/Caution/Advisory Displays (Sheet 9)

Warning/Cation/Advisory Displays

ADVISORIES (ALL AIRPLANES)

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
A/P	Autopilot mode selected	Information
ARMAMENT ADVISORIES	Refer to A1-F18AC-NFM-100	
ATTH	Autopilot attitude hold mode selected	Information
BALT	Autopilot barometric altitude hold mode selected	Information
L BAR	Launch bar extended on the deck	Information
BIT	Built-in test failure	1. MENU BIT - CHECK
CRUIS	Gain switch in ORIDE and flap switch AUTO ● Leading and trailing edge flaps about 3° ● Flaps optimized for 35,000 feet, Mach 0.7, and 2° AOA	Information
FLAPS	Flaps in transit (5.3.1 PROM) Abnormal flap condition (After 7.0 PROM)	Information
FUEL	FUEL LO, BINGO, or CG caution BIT failure	FUEL BIT - INITIATE
FULL	Flaps full down (5.3.1 PROM) Flap switch FULL (After 7.0 PROM)	Information
HALF	Flaps ½ down (5.3.1 PROM) Flap switch HALF (After 7.0 PROM)	Information
L HEAT R HEAT	Designated engine anti-ice valve open	Information
HSEL	Autopilot heading hold mode selected	Information
LAND	Gain switch in ORIDE and flap switch HALF or FULL ● Leading edge flaps 17° ● Leading edge flaps optimized for 8.1° AOA (133 knots) ● Trailing edge flaps 30° or 45°	Information
LEFT	STEADY - Left gear down and locked	Information
	FLASHING - Left gear planing link failed	1. Make fly-in arrestment with LSO assistance, if available

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Figure 5-1. Warning/Caution/Advisory Displays (Sheet 10)

Warning/Cation/Adivsory Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
ADVISORIES (ALL AIRPLANES)		
~~LOAD~~	Weapons load failure or error	1. Check SMS for proper configuration
M4 OK	Mode 4 valid interrogation/ reply	Information
NOSE	Nose gear down and locked	Information
RALT	Autopilot radar altitude hold mode selected	Information
READY (APU)	APU on line and ready	Information
READY (Fire ext)	Fire extinguisher armed	Information
RESET	Reset cleared FCS failure	Information
~~RESET~~	RESET did not clear FCS failure	Information
RIGHT	STEADY - Right gear down and locked	Information
	FLASHING - Right gear planing link failed	1. Make fly-in arrestment with LSO assistance, if available
SKID	Gear down and anti-skid switch - OFF	Information
SPD BRK	Speed brake not fully retracted	Information
TRIM	Control surfaces trimmed for takeoff	Information

✱ Immediate action item
★ Discussion in section V

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Figure 5-1. Warning/Caution/Advisory Displays (Sheet 11)

PART 1 - GROUND EMERGENCIES

ENGINE FAILS TO START

If no EGT rise within 20 seconds after throttle advanced -

1. Throttle - OFF
2. Continue cranking for 30 seconds
3. Throttle - IDLE

If still no start -

4. Throttle - OFF

After 30 seconds -

5. Engine crank switch - OFF
6. APU switch - OFF

HOT START

If EGT climbs rapidly thru 750°C -

*1. Throttle - OFF
2. Engine - CRANK UNTIL EGT BELOW 200°C
   If starter has cut out, reengage when rpm below 30%..

If 815°C not exceeded -

3. Throttle - IDLE

If 815°C exceeded or second hot start -

3. Throttle - OFF
4. Engine - CRANK FOR 3 MINUTES
   If starter has cut out, reengage when rpm below 30%.
5. APU switch - OFF

GROUND FIRE

If a FIRE or APU FIRE light comes on, refer to the Warning/Caution/Advisory Displays chart, figure 5-1. A fire on the ground may not be accompanied by a FIRE warning light. To isolate the fuel tanks in case of fire on the ground, leave the battery switch ON, press both engine FIRE warning lights, and place the APU switch OFF. Actuating the engine FIRE warning lights will close the airframe mounted fuel shutoff valves and the crossfeed valve. The engines will run for about 40 seconds at IDLE after the FIRE warning lights are pressed. This consumes all fuel between the airframe mounted fuel shutoff valves and the engines. If smoke or fire is present or fire is confirmed by the ground crew, place both throttles OFF and exit the airplane. If a fire occurs during hot refueling, the pilot must decide whether or not to taxi clear.

EGRESS

The canopy jettison system uses rocket thrusters to separate the canopy. These rockets produce considerable flame directed down over the fuselage and present a hazard to the ground crew in the immediate vicinity. The rocket flame provides an ignition source for spilled fuel or hydraulic fluid. The canopy control switch should be used to open the canopy unless there are overriding considerations. The jettison handle is the only means of opening the canopy from the TF rear cockpit.

*1. Manual override handle - PRESS RELEASE BUTTON AND ROTATE AFT
*2. Egress
   a. Canopy - OPEN
      (1) Canopy control switch (TF front cockpit only)
          If weight is off the left main landing gear (gear up landing, etc.) the internal canopy switch open solenoid is inoperative. The canopy switch must then be held to the OPEN position with the right hand while the left hand disconnects from seat attach fittings per the subsequent steps in this procedure. After the canopy is open (7 to 8 seconds) the remaining steps can be performed.
      (2) Canopy jettison handle

WARNING

Rocket thrusters may ignite spilled fuel or hydraulic fluid and may injure ground crew in the immediate vicinity.

      (3) Canopy handcrank (TF front cockpit only)
          The canopy may be opened more rapidly by pushing up on the canopy with the right hand while cranking with the left.
   b. Lap belt - RELEASE
   c. Shoulder harness - RELEASE
   d. Oxygen hose - DISCONNECT

WARNING

Care should be taken to pull up on the knurled knob just above the connection. Failure to pull up on ring on knob will prevent hose disconnecting.

DIRECTIONAL CONTROL/BRAKE PROBLEM

Directional control problems may be caused by a blown tire, defective nosewheel steering, defective anti-skid, or a faulty brake. It may be difficult to identify the problem source and time is usually critical; therefore, this procedure is designed to regain directional control/brakes in minimum time regardless of cause.

If nosewheel steering failure suspected –

*1. Paddle switch – PRESS

If directional control/brake problem remains –

*2. Nosewheel steering – ENGAGE
*3. Brakes – RELEASE
*4. Emergency brake handle – PULL TO DETENT
*5. Brakes – APPLY

PART 2 – TAKEOFF EMERGENCIES

LAUNCH BAR MALFUNCTION

Refer to L BAR red light in the Warning/Caution/Advisory Displays chart, figure 5-1. On airplanes thru 161715, an L BAR red light on the ground indicates that the launch bar switch is in EXTEND with either throttle at MIL or above. On all airplanes, if the light is on with the switch in RETRACT, an electrical fault exists which will prevent launch bar retraction after launch. If the L BAR red light is on after takeoff the launch bar is not latched up and the nosewheel will not retract. Get a visual inspection if possible. Even though the launch bar appears to be retracted, it may extend on landing if the red L BAR light is on. An extended launch bar may engage an arresting gear cable during a CV landing or during field takeoff or landing.

AIRPLANE SETTLING OFF CATAPULT

Off the catapult, a thrust loss or flap retraction will cause the airplane to settle and you do not have time to determine the specific cause. If the settling cannot be stopped immediately, you must eject immediately. If you have time, the following procedure is best for controlling settle when the cause is unknown.

*1. Throttles – MAX AB
*2. Maintain ON-SPEED AOA
*3. External stores – JETTISON

If settle not stopped –

*4. Eject

ABORT

The decision to abort or continue takeoff depends on many items specific to the emergency. No rule can be made which will fit every situation. Items to be considered include the following:

Emergency condition
Weight
Speed
Runway remaining
Braking conditions
Arresting gear availability
Wind
Weather

Normally, an abort is accomplished by placing the throttles to IDLE and applying the brakes. If your speed is above the computed maximum abort speed from section XI and you must rely on an arrestment to stop, the seriousness of the emergency and your good judgement will control whether to abort or continue the takeoff. The ejection seat provides safe escape at ground level. If a safe aborted takeoff cannot be made and takeoff is impossible, eject. Make an arrestment if you have any stopping problem. Lower the hook in time for it to extend fully (normally 1000 feet before wire). Tell the tower you intend to arrest. Line up on runway centerline. At high speed, avoid large pitch control inputs.

*1. Throttles – IDLE
*2. Brakes – APPLY
3. Hook – DOWN (if required)

ENGINE FIRE/LOSS OF THRUST ON TAKEOFF

An engine fire or loss of thrust on takeoff requires consideration of several factors. If it occurs early enough to permit a safe abort, abort. If it occurs after you are committed to takeoff, consider:

- Single engine minimum control airspeed at MIL and MAX power.
- Jettison of external stores to reduce gross weight.

When airborne, raise the landing gear to improve acceleration and climb at a low angle of attack to a safe altitude/airspeed.

If decision to stop is made –

*1. Abort

If takeoff is continued -

*1. Throttles - MIL or MAX
*2. Maintain ON-SPEED AOA and balanced flight.
3. External stores - JETTISON (if required)

BLOWN TIRE ON TAKEOFF

A blown nosewheel tire may cause engine FOD. A blown main gear tire may damage the flaps. Any blown tire may damage the gear doors. If decision to stop is made, the primary danger is loss of directional control. Do not attempt to taxi.

If decision to stop is made -

1. Throttles - IDLE
2. Emergency brake handle - PULL TO DETENT
3. Use light braking on good tire
4. Hook - DOWN (if required)
5. Do not retract flaps

If takeoff is continued -

1. Gear and flaps - LEAVE DOWN (if practical)
   Retraction of gear or flaps may cause additional damage to flaps or gear doors already damaged by tire pieces.
2. Engine instruments - MONITOR
   If nose gear blown, engines may have FOD

LANDING GEAR FAILS TO RETRACT

1. Gear handle - DOWN
2. Do not cycle landing gear
   Check for planing link failure and refer to Landing Gear Emergencies - Landing, this section.

PART 3 - INFLIGHT EMERGENCIES

ENGINE FIRE IN FLIGHT

Refer to FIRE light in the Warning/Caution/Advisory Displays, figure 5-1. If an engine fire is indicated by a FIRE warning light, confirm the fire. A fire may be confirmed if the FIRE warning light stays on with the throttle at IDLE, or the light goes off and the system checks bad. High fuel flow, high EGT, rough running, or smoke and fumes may also confirm a fire. When a fire is confirmed and the fire extinguishing system is actuated, the throttle should not be placed OFF until the rpm starts to decrease to permit the engine to burn the fuel downstream from the fuel shutoff valve. The fuel shutoff valve may be reopened by again pressing the FIRE light.

AFTERBURNER FAILURE

Afterburner failure can be recognized by nozzle position. This may be the only symptom that is immediately recognizable. The afterburner has continuous ignition and attempts to light any time the throttle is above 50% afterburner and the afterburner is not lit. If afterburner does not light after selection or blowout, reduce throttle to MIL and reselect afterburner when in a better environment.

RUNAWAY ENGINE

A runaway engine may remain at high or low power or the power may vary randomly. The failure may be due to throttle linkage, fuel control failure, or failure of the MIL power lockup system. If the engine fails to high power and the MIL power lockup system is the cause, slowing to 250 knots and lowering the landing gear may allow normal engine operation. It may be possible to control thrust using the ATC. If thrust is too high to permit landing, shut down the engine with the throttle. If the engine cannot be shut down with the throttle, press the FIRE light.

ENGINE FAILURE

If an engine fails, the corresponding generator and HYD 1 (left engine) or HYD 2 (right engine) system will be lost. A windmilling engine can cause repeated flight control transients as the hydraulic switching valves operate. Various FCS cautions will come on intermittantly. After the rpm has decreased to near zero, the transients will cease, the FCS cautions will go off, and FCS operation will be normal. To prevent repeated switching valve cycling, avoid stabilized flight where engine windmilling rpm produces hydraulic pressure fluctuations between 800-1600 psi. Either generator supplies sufficient power to operate all electrical items. If the failed engine core is rotating freely and rpm is below 30%, use the APU or engine crossbleed to retain both HYD systems. Refer to Hydraulic Failure, this section, for results of loss of a hydraulic system. If the right engine is being rotated with crossbleed to provide normal systems operation and fuel flow on the left engine is reduced below 2000 pph (as during landing), the right engine hydraulic pump may not provide sufficient flow for nosewheel steering and normal brakes.

ENGINE STALL

A stall may produce an audible bang or bangs and is usually self-clearing. If a stall does not clear:

*1. Throttles - REDUCE

If stall does not clear at IDLE –

*2. Throttle affected engine – OFF

RESTART

Ignition is on with throttle at IDLE or above and rpm between 12% and 45% with engine flamed out. Continuing automatic restart attempts at high altitude or high AOA may cause the engine to overtemp. In this case, place the throttle OFF until in a better start environment. The optimum restart envelope is below 25,000 feet. If crossbleed is not used, at least 350 knots is required to maintain 12% rpm. Refer to figure 5-2 thru 5-5.

If rpm above 30% –

1. Throttle – ABOVE IDLE

If rpm below 30% –

1. Throttle other engine – 80% MINIMUM AND FUEL FLOW 1900 PPH MINIMUM
2. Throttle bad engine – ABOVE IDLE
3. Engine crank switch – BAD ENGINE

HYDRAULIC FAILURE

Refer to Hydraulic Flow Diagrams figure 5-6 for systems affected. A hydraulic leak may occur in a part of the system not protected by reservoir level sensing such as the pump supply line or the pump pressure line upstream of the shutoff valves. If this occurs, the circuit A caution (HYD 1A or HYD 2A) will come on and, sometime later, will go off as the circuit B caution (HYD 1B or HYD 2B) comes on. At this time, the indication sequence is the same as for a circuit B leak; however, in this case, the circuit B caution will go off sometime later and the circuit A caution will remain off. For a relatively short time (less than 7% of the time since the circuit A caution first appeared), both circuits A and B will operate and hydraulic pressure will indicate normal since there is a small amount of fluid remaining in the reservoir when the circuit B caution goes off.

The only single failure indication which requires pilot action is a HYD 2A caution.

The result of combinations of failures can be analyzed by reference to the Hydraulic Flow Diagram, figure 5-6. A multiple failure which affects the flight controls will cause an FCS caution.

HYD 2A FAILURE

A HYD 2A failure causes loss of normal landing gear extension, normal brakes and normal refuel probe operation. Extend the landing gear as soon as practical. Anti-skid is inoperative and a Short Field Arrestment is recommended.

To extend landing gear –

1. Slow below 180 knots
2. Landing gear handle – DOWN, ROTATE 90° CLOCKWISE, PULL TO DETENT
   If the landing gear handle will not move to the down position, pull the landing gear circuit breaker then rotate the handle 90° and pull until the handle locks in the detent. The gear will extend by the emergency method with the gear handle up. The red light in the gear handle will remain on with the gear down and locked.

CAUTION

If the landing gear is lowered by the emergency method with the gear handle up, the gear handle may move enough to cause gear retraction without deliberate pilot action unless the landing gear circuit breaker is pulled.

After landing –

1. Emergency brake handle – PULL TO DETENT
   Do not rotate emergency brake handle as this will set the parking brake.

To extend refuel probe –

1. Refuel probe switch – EMERG EXTD

HYD 2A AND 2B FAILURE

1. Make a Short Field Arrestment, if practical

If arrested landing not practical –

2. With little or no crosswind, disengage nosewheel steering after touchdown
3. Emergency brake handle – PULL TO DETENT
4. Use steady brake pressure (Do not pump)

FUSELAGE FUEL LEAK

A fuselage fuel leak may be noted by fuel streaming, a rapid decrease in fuel quantity, or erratic engine operation. The leak may occur upstream of the throttle operated fuel shutoff valve in the engine fuel control. Pressing a FIRE warning light will close the airframe mounted fuel shutoff valve for that engine at the feed tank. If it is not obvious which side is leaking, an L or R BOOST LOW caution, increased fuel flow on one side, a rapid decrease in one feed tank fuel quantity, or erratic engine operation may provide an indication of which side is leaking. Land as soon as possible. Enroute to landing, try to isolate the leak. Shut down the engine on the suspected side using the FIRE warning light. If the leak continues, restart that engine and shut down the other engine. If the leak still continues, restart the dead engine.

Spooldown Restart Envelope

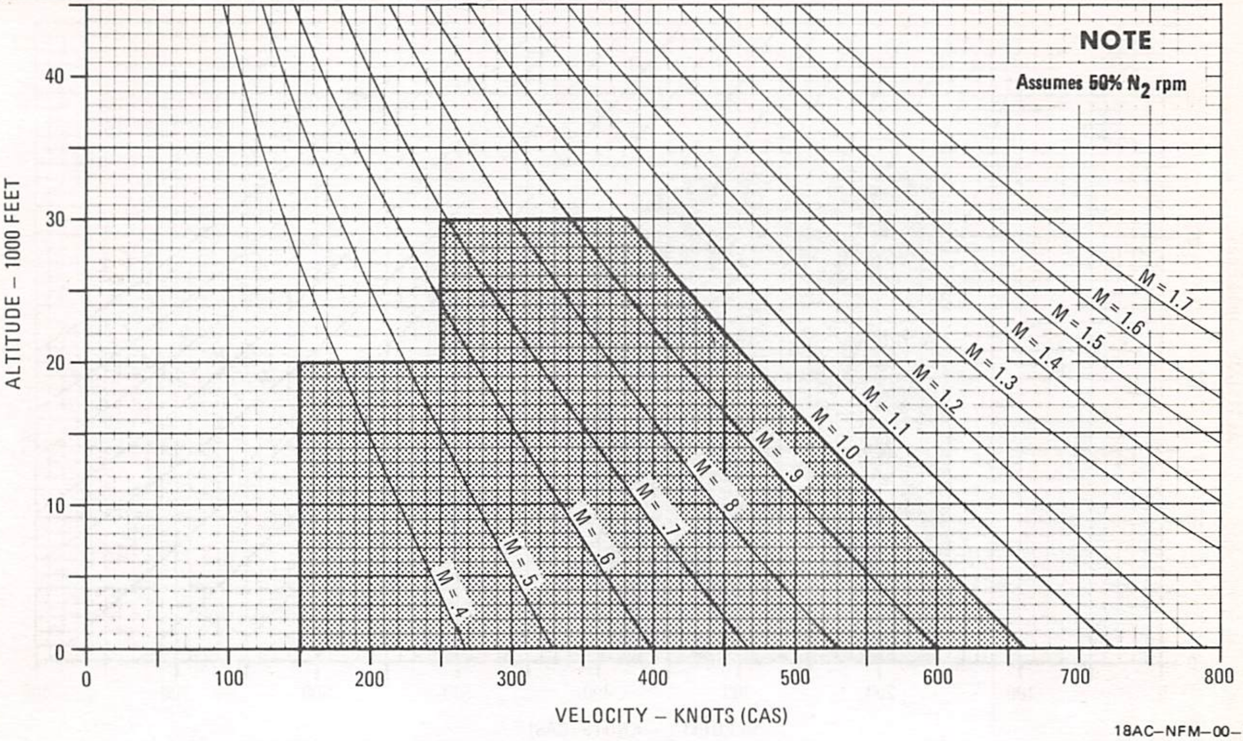

Figure 5-2. Spooldown Restart Envelope

Windmill Restart Envelope

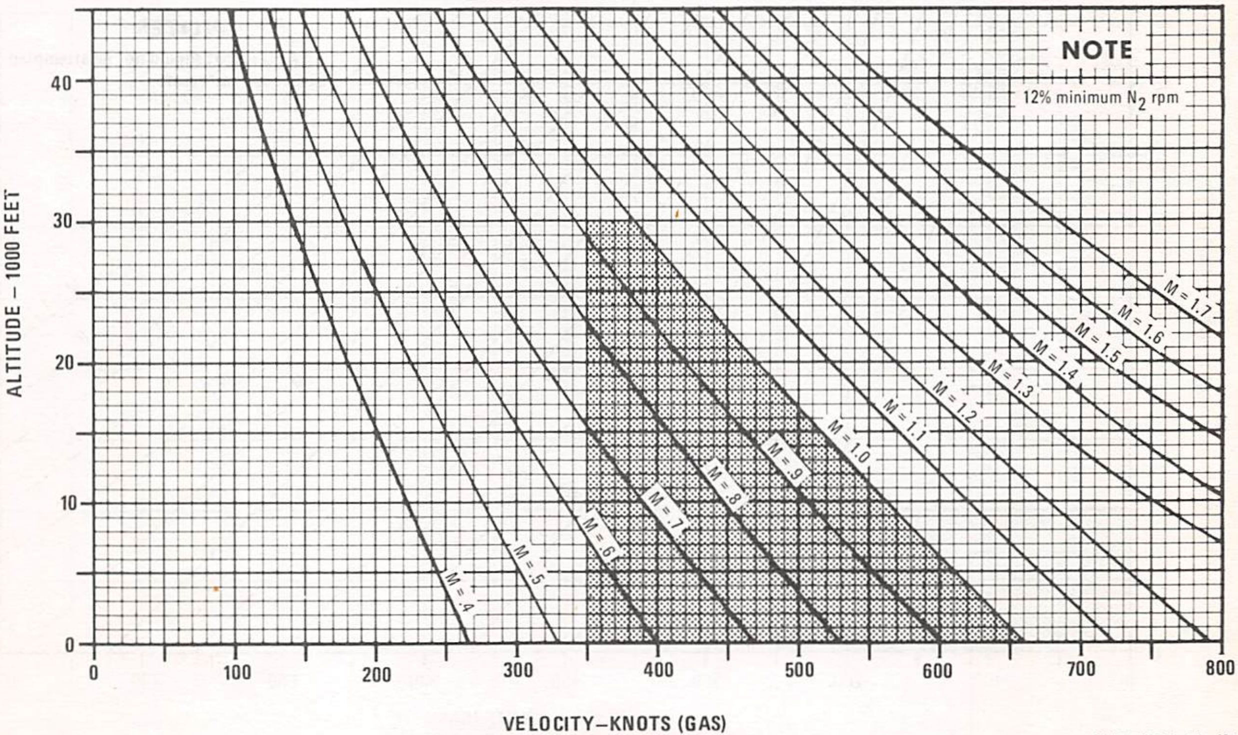

Figure 5-3. Windmill Restart Envelope

Crossbleed Restart Envelope

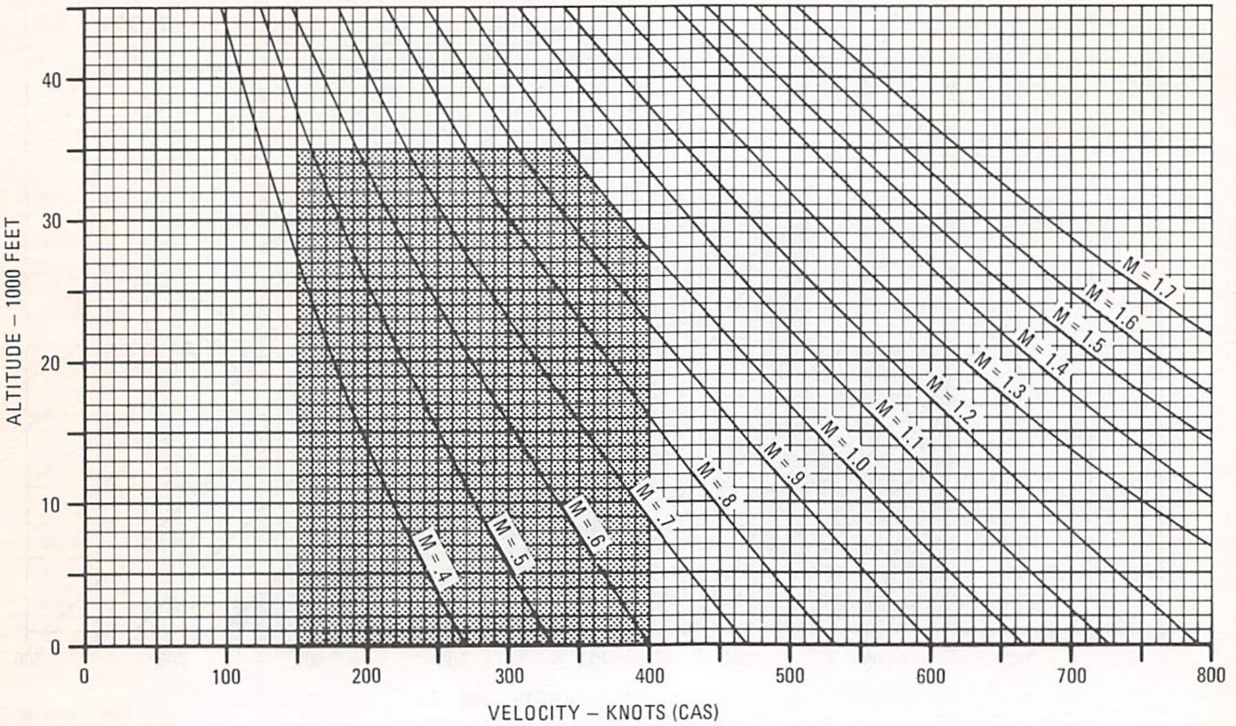

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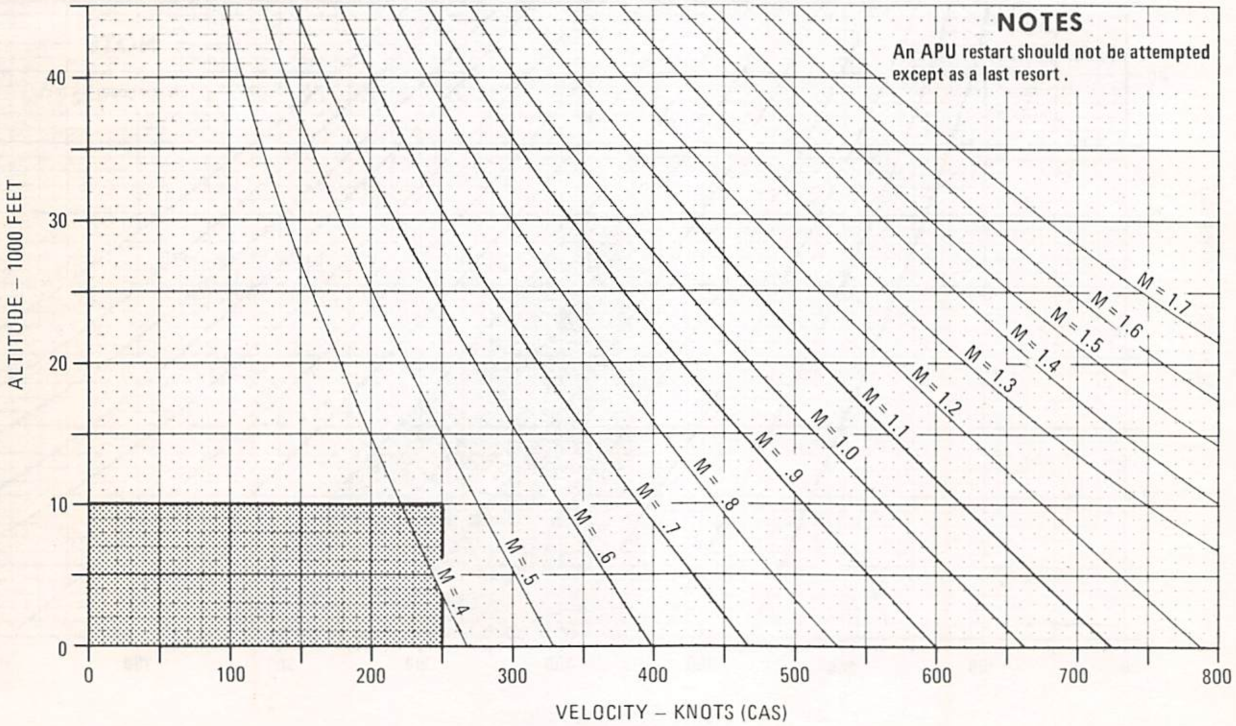
Figure 5-4. Crossbleed Restart Envelope

APU Start and Engine Restart Envelope



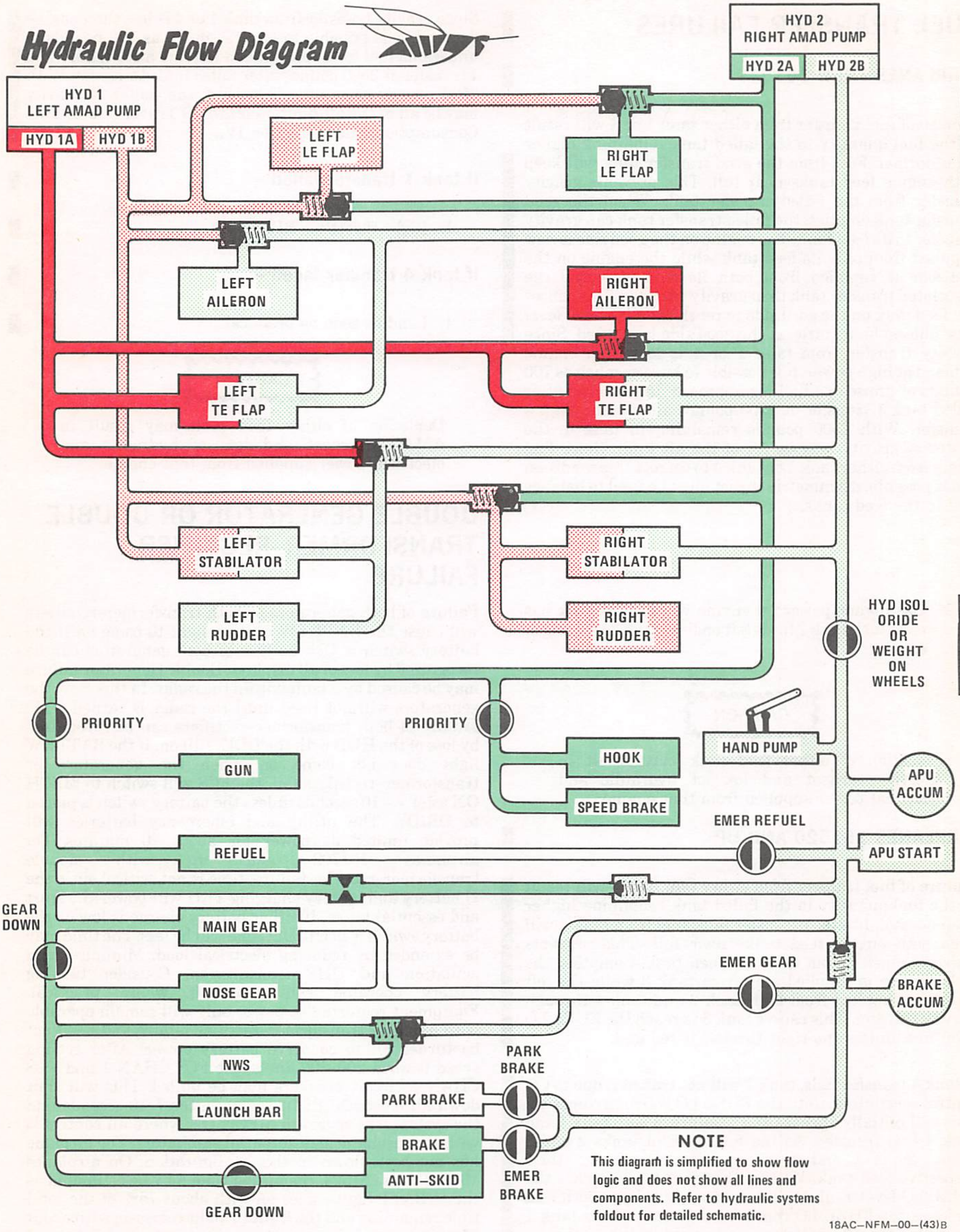
NOTES

An APU restart should not be attempted except as a last resort.

18AC–NFM–00–(86) A

Figure 5-5. APU Restart Envelope

Hydraulic Flow Diagram



NOTE

This diagram is simplified to show flow logic and does not show all lines and components. Refer to hydraulic systems foldout for detailed schematic.

18AC-NFM-00-(43)B
RG

Figure 5-6. Hydraulic Flow Diagram

FUEL TRANSFER FAILURES

AIRPLANES THRU 161519

Failure of fuel transfer from either tank 1 or 4 will result in the fuel quantity in the failed tank remaining higher than normal. Fuel from the good transfer tank will keep both engine feed tanks near full. This prevents gravity transfer from the failed transfer tank. When the good transfer tank empties, the failed transfer tank can gravity transfer to its feed tank. The engine on the good side is now supplied from only its feed tank while the engine on the bad side is supplied from both its feed tank and the associated transfer tank thru gravity transfer. This causes the feed tank on the good side to reach the FUEL LO level first unless the throttle on the good side is reduced. Since gravity transfer from tank 1 or 4 is less than engine demand at high power, it is possible to have as much as 700 pounds of unuseable fuel for approach and landing after failed tank 1 transfer or 2500 pounds after failed tank 4 transfer. With 2500 pounds remaining in tank 4, the center of gravity may be aft of the aft limit. Since fuel dump from either tank 1 or tank 4 to correct this condition is not possible, asymmetric thrust must be used to balance fuel in the feed tanks.

1. Use higher power on engine whose feed tank has most fuel (tank 2 feeds left engine, tank 3 feeds right engine).

CAUTION

Depletion of either feed tank may result in AMAD overheat and loss of hydraulic and electrical power supplied from that engine.

AIRPLANES 161520 AND UP

Failure of fuel transfer from either tank 1 or 4 will result in the fuel quantity in the failed tank remaining higher than normal. If tank 1 transfer fails, fuel from tank 4 will keep both engine feed tanks near full. This prevents gravity transfer from tank 1. When tank 4 empties, the right engine is supplied only from tank 3 while the left engine is supplied from both tank 2 and tank 1 through gravity transfer. This causes tank 3 to reach the FUEL LO level first unless the right throttle is reduced.

If tank 4 transfer fails, tank 1 will not transfer, due to CG control scheduling, until the FUEL LO warning comes on. This will initially appear to be a failure of both tank 1 and tank 4 fuel transfer. As the fuel level in tanks 2 and 3 drops, tanks 1 and 4 will gravity transfer to their respective feed tank. When either feed tank reaches the FUEL LO level, tank 1 will transfer cyclically to both feed tanks as the FUEL LO comes on and goes off. As tank 1 transfers, the CG will move aft rapidly. When tank 1 empties, tank 4 will continue gravity transfer to tank 3 as the tank 3 fuel level drops.

Since gravity transfer from tank 1 or 4 is less than engine demand, it is possible to have as much as 700 pounds of unuseable fuel for approach and landing after failed tank 1 transfer or 2500 pounds after failed tank 4 transfer. With 2500 pounds remaining in tank 4, the center of gravity may be aft of the aft limit. Refer to CG Travel Due To Fuel Consumption charts, Section IV.

If tank 1 transfer failed -

1. Right throttle - REDUCE

If tank 4 transfer failed -

1. Land as soon as practical

CAUTION

Depletion of either feed tank may result in AMAD overheat and loss of hydraulic and electrical power supplied from that engine.

DOUBLE GENERATOR OR DOUBLE TRANSFORMER–RECTIFIER FAILURE

Failure of both generators or both transformer–rectifiers will cause the BATT SW caution light to come on if the battery switch is ON. Failure of both generators can be recognized by loss of all displays. Double Generator failure may be caused by a fault within the radar. In this case, the generators will not reset until the radar is turned OFF. Failure of both transformer–rectifiers can be recognized by loss of the HUD with the DDI's still on. If the BATT SW light does not come on when the generators or transformer–rectifiers fail, the FCS will switch to MECH ON after 7 – 10 seconds unless the battery switch is placed to ORIDE. The utility and emergency batteries will provide limited dc power for about 20 minutes. On airplanes 161702 and up with double transformer–rectifier failure, time is not critical since the U battery and battery charging TRU will power the start and essential buses. If either battery charge is low or the battery switch is in ORIDE, time will be less. The time may be extended by reducing electrical load. Minimize trim actuation and UHF transmission. Consider turning battery operated equipment off where practical. Equipment requiring ac power only will remain operable with a double transformer–rectifier failure and need not be turned off to conserve battery power. After setting speed beween 200–300 knots, the FCS CHAN 1 and FCS CHAN 2 circuit breakers may be pulled. This will shut down all electrical flight control after 7–10 seconds and the system will revert to MECH ON where all control is with the mechanical differential stabilators. The airplane has not been flown in this configuration. On airplanes 161353 thru 161528, remaining time may be estimated as the U BATT light comes on with about 75% of the total time remaining and the E BATT light comes on with about 25% of the total time remaining. On airplanes 161702 and up, battery status is indicated on the U/E voltmeter. External fuel will not transfer. External stores may be jettisoned. Reset FCS CHAN 1 and FCS CHAN 2 circuit breakers before landing. Refer to Emergency Power Distribution, figure 5-7, for operative and inoperative equipment.

1. Generator switches - CYCLE (double generator failure)
2. Conserve battery power

NOTE

On airplanes 161702 and up with double transformer-rectifier failure, the battery charger should provide enough power (battery switch ON) to keep the essential dc bus energized and the U battery charged.

3. Land as soon as possible
4. If FCS CHAN 1 and 2 circuit breakers pulled - RESET BEFORE LANDING
5. Use landing gear emergency extension procedures
6. Make a Short Field Arrested Landing (if available)

AMAD CAUTION

An L AMAD or R AMAD caution indicates that the left or right AMAD oil is too hot. Low altitude flight on a hot day with less than 4000 pounds fuel may cause an AMAD caution. A climb to cooler air may reduce AMAD oil temperature. An over-serviced AMAD, AMAD heat exchanger failure, hot fuel recirculation system failure, or motive flow system failure will cause an AMAD caution. An empty feed tank or BOOST LO caution will cause loss of AMAD cooling.

Continued operation with an AMAD caution may cause loss of the associated generator. Prolonged operation of a hot AMAD may result in an engine bay fire. If an AMAD caution is accompanied by generator loss, land as soon as practical. If a landing cannot be made within 15 minutes after an AMAD and GEN caution, consider shutting down the associated engine. The engine may be restarted for landing, but should be shut down as soon as the airplane is stopped. Refer to Warning/Caution/Advisory Displays, Figure 5-1.

During ground operation after flight, an AMAD caution may occur due to the lack of ram air cooling and low fuel state. Below 1000 pounds fuel remaining and above 30°C, an AMAD caution will appear almost immediately. Above 3000 pounds of fuel remaining and below 30°C, an AMAD caution should not occur. Between these conditions, the time before an AMAD caution will appear is a function of fuel state and ambient temperature (15 minutes at 24°C and 2000 pounds fuel). Lower fuel quantities and higher ambient temperatures will reduce the time before an AMAD caution will appear. Shutting down an engine (left engine shutdown preferred) will extend the ground operating time. If the AMAD caution appears, shut down the associated engine.

AMAD PR CAUTION

An L AMAD PR or R AMAD PR caution indicates that the left or right AMAD oil pressure is low. The AMAD can operate 30 minutes after loss of oil without a catastrophic failure but the generator will fail shortly after loss of oil. Refer to Warning/Caution/Advisory Displays, figure 5-1.

COCKPIT TEMPERATURE HIGH

1. Cabin temperature knob - FULL COUNTERCLOCKWISE
   If the cabin temperature knob is full clockwise with the cabin temperature knob in MANUAL, cockpit temperature can reach 190°F.
2. ECS mode switch - MAN

If temperature still high -

3. Cabin pressure switch - RAM/DUMP

If temperature not reduced -

4. Bleed air knob - OFF
   When bleed air secured, anticipate:
   a. Loss of crossbleed start capability.
   b. Loss of ECS and pressurization.
   c. Loss of external tank transfer.
   d. Illumination of TANK PRESS and AV AIR HOT lights.
5. Land as soon as practical

COCKPIT SMOKE, FUMES, OR FIRE

Consider all unidentified fumes in the cockpit as toxic. Do not confuse condensation from the air conditioning system with smoke. The most probable source of visible smoke or fumes in the cockpit is from the engine bleed or residual oil in the ECS ducts. This smoke is blue gray in color, has a characteristic pungent odor, and may cause the eyes to sting. Another source of smoke or fumes is an electrical malfunction or overheat of equipment located in the cockpit. In the event of electrical short or overload condition, this equipment may generate electrical smoke (usually white or gray in color) but should not cause an open fire since cockpit equipment uses very little electrical current. Cockpit electrical wiring insulation may smolder and create smoke, but will not erupt into a seriously damaging fire.

*1. Cabin pressure switch - RAM/DUMP
   Descend below 25,000 feet, if practical
*2. Cabin temperature knob - FULL COUNTERCLOCKWISE
3. Speed - 200 to 300 KNOTS

Emergency Power Distribution

BOTH GENERATORS INOPERATIVE
BATTERIES IN HIGH STATE OF CHARGE

OPERATIVE EQUIPMENT

ENGINE
- ★ Afterburner ignition
- ★ Anti–icing
- APU ready light
- APU start
- Bleed air leak detectors
- ★ Engine ignition
- Engine monitor indicator
- Engine start
- Fire detectors and extinguishers
- Fuel dump
- ★ Internal fuel transfer

FLIGHT CONTROLS
- DEL (direct electrical link)
- CAS
- Flaps
- Flap position indicator
- Manual flight control mode select actuator (ratio changer)
- Pitch trim actuator

FLIGHT INSTRUMENTS
- Attitude reference indicator(s)
- ★ Standby airspeed/mach indicator(s)
- ★ Standby altimeter(s)
- ★ Standby rate–of–climb indicator(s)
- Standby turn needle(s)

LIGHTING EQUIPMENT
- Caution lights panel (less GEN and fuel level low LTS)
- [1] Emergency instrument light
- Master caution light(s)
- Utility flood light(s)

NAVIGATION EQUIPMENT
- [6] COMM 1 R/T
- IFF emergency

OTHER–
- ★ Arresting hook extension
- Canopy
- Emergency air refueling
- Emergency jettison
- FCS ram air selection
- [2] Intercom
- ★ Landing gear (emergency system)
- Landing gear position indicator
- Voice alerts (APU fire, engine fire, bleed air)

INOPERATIVE EQUIPMENT

ENGINE
- Anti–ice control
- Bleed air system
- External fuel transfer
- Fuel low warning caution light
- Fuel tank pressure light
- Fuel quantity
- Inlet duct doors
- Inlet ice detector
- Internal fuel tank pressurization
- Internal wing fuel inhibit
- N_H lockup
- Throttle Boost
- Wing diverter valves

FLIGHT CONTROLS
- Autopilot
- Flight control stick stop solenoid
- Speedbrake
- Speedbrake advisory light

FLIGHT INSTRUMENTS
- AOA indexer lights
- HUD
- Left and right pitot heaters

LIGHTING EQUIPMENT
- Approach lights
- Caution/advisory displays
- Console lights
- Flood lights
- Formation lights
- GEN caution lights
- Instrument lights
- Landing/taxi lights
- Lights test switch
- Position lights
- Strobe lights

NAVIGATION EQUIPMENT
- ADF
- COMM 2 R/T
- Electronic altimeter
- IFF
- ILS
- INS
- KY–58
- Radar beacon
- TACAN

OTHER–
- Air refueling light and normal probe extention
- Anti–skid
- Arresting hook retraction
- Battery charger(s)
- Cabin ram air selection
- Cockpit DDI/HI's
- Data link
- Hook warning light
- Hydraulic pressure indicator
- Landing gear (normal system)
- Landing gear warning tone
- Master caution tone
- Nosewheel steering
- Oxygen gage
- Radar
- [3] ALR–67 radar warning rcvr
- Selective jettison
- Voice alerts (fuel low, bingo, altitude, flight computer hot, flight controls, mode 4 reply, engine)
- Voice recorder
- Weapons fire/launch/release
- Windshield anti–ice/rain removal

★ Equipment still operative after batteries depleted.

[1] F/A's and FWD CKPT of TF/A'S only
[2] TF/A'S
[3] Airplanes 161702 and up
[4] Airplanes 161353 thru 161528
[5] Back–up mode operative only
[6] Frequency selection lost. Will operate on last selected frequency. Guard transmit receive can be selected by COM G XMT switch.

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Figure 5–7. Emergency Power Distribution (Sheet 1 of 2)

Emergency Power Distribution

BOTH TRANSFORMER-RECTIFIERS INOPERATIVE
BOTH GENERATORS OPERATIVE
BATTERIES IN HIGH STATE OF CHARGE

OPERATIVE EQUIPMENT

ENGINE

- ★ Afterburner ignition
- ★ Anti-icing
- ★ ★ APU ready light
- ★ ★ APU start
- ★ ★ Bleed air leak detectors
- ★ Engine ignition
- ★ ★ Engine monitor indicator
- ★ ★ Engine start
- ★ ★ Fire detectors and extinguishers
- ★ ★ Fuel dump
- ★ Fuel quantity
- ★ Internal fuel transfer

FLIGHT CONTROLS

- ★ ★ CAS
- ★ ★ DEL (direct electrical link)
- ★ ★ Flaps
- ★ ★ Flap position indicator
- ★ ★ Manual flight control mode select actuator (ratio changer)
- ★ ★ Pitch trim actuator

FLIGHT INSTRUMENTS

- ■ ★ ★ Attitude reference indicator(s)
- ★ Left and right pitot heaters
- ★ Standby airspeed/mach indicator(s)
- ★ Standby altimeter(s)
- ★ Standby rate–of–climb indicator(s)
- ★ ★ Standby turn needle(s)

LIGHTING EQUIPMENT

- ★ Caution/advisory displays
- ★ ★ Caution lights panel (less gen and fuel level low lts)
- ★ Console lights
- ★ ★ [1] Emergency instrument light
- ★ Flood lights
- ★ ★ Instrument lights
- ■ ★ ★ Master caution light(s) (and tone)
- ★ ★ Utility flood light(s)

NAVIGATION EQUIPMENT

- ★ ★ [5] COMM I R/T
- ★ Electronic altimeter
- ★ ★ IFF (emergency)

OTHER –

- ★ Arresting hook extension
- [3] Battery charger
- ★ ★ Canopy
- ★ Cockpit DDI/HI's
- ★ ★ Emergency air refueling
- ★ ★ Emergency jettison
- ★ ★ FCS ram air selection
- ★ Hydraulic pressure indicator
- ★ ★ [2] Intercom
- ★ Landing gear (emergency system)
- ★ ★ Landing gear position indicator
- ★ Oxygen gage
- Voice alerts (all) ■

INOPERATIVE EQUIPMENT

ENGINE

- Anti-ice control
- Bleed air system
- External fuel transfer
- Fuel low warning caution light
- Fuel tank pressure light
- Inlet duct doors
- Inlet ice detector
- Internal fuel tank pressurization
- Internal wing fuel inhibit
- N_H lockup
- Throttle Boost
- Wing diverter valves

FLIGHT CONTROLS

- Autopilot
- Flight control stick stop solenoid
- Speed brake
- Speed brake advisory light

FLIGHT INSTRUMENTS

- AOA indexer lights
- HUD

LIGHTING EQUIPMENT

- Approach lights
- Formation lights
- GEN caution lights
- Landing/taxi lights
- ■ Lights test switch
- Position lights
- Strobe lights

NAVIGATION EQUIPMENT

- ADF
- COMM 2 R/T
- IFF
- ILS
- INS
- KY–58
- Radar beacon
- TACAN

OTHER –

- Air refueling lights and normal probe extention
- Anti–skid
- Arresting hook retraction
- [4] Battery chargers
- Cabin ram air selection
- Data link
- Hook warning light
- Landing gear (normal system)
- Landing gear warning tone
- ■ Nosewheel steering
- Radar
- [3] ALR–67 Radar warning rcvr
- Selective jettison
- [3] Voice recorder
- Weapons fire/launch/release
- Windshield anti–ice/rain removal

★ Equipment still operative after batteries depleted.

★ ★ On 161353 thru 161528 equipment becomes inoperative with batteries depleted.
On 161702 and up, equipment remains operative by action of battery charger (battery switch ON).

[1] F/A'S and FWD CKPT of TF/A'S only
[2] TF/A'S only
[3] Airplanes 161702 and up
[4] Airplanes 161353 thru 161528
[5] Back–up mode operative only
[6] Frequency selection lost. Will operate on last selected frequency. Guard transmit–receive can be selected by COM G XMT switch.

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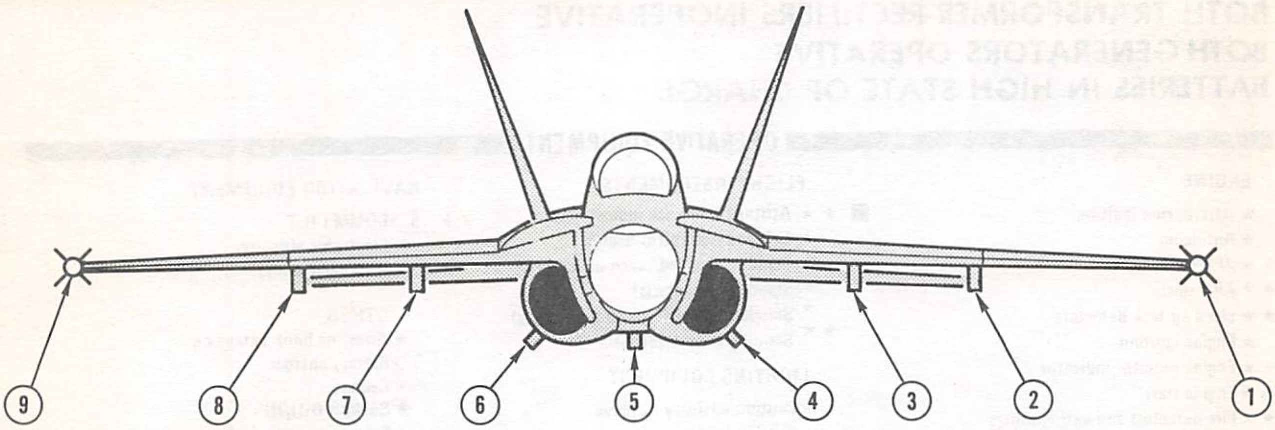
Figure 5-7. Emergency Power Distribution (Sheet 2)

External Stores Jettison Chart



EXTERNAL STATION(S) (STORES JETTISONED)	GEAR HANDLE POSITION	JETTISON CONTROLS	JETTISON PROCEDURE
2, 3, 5, 7 and 8 (All stores on BRU 32/A bomb racks)	DOWN ★ or UP	Emergency Jettison Button	Emergency Jettison Button – PUSH
4 (Sparrow Missile)	UP ★★	Selective Jettison Knob & Master Arm Switch	Select Jett Knob – L. FUS MSL Master Arm Switch – ARM Select Jett Button – PUSH
6 (Sparrow Missile)	UP ★★	Selective Jettison Knob & Master Arm Switch	Select Jett Knob – R. FUS MSL Master Arm Switch – ARM Select Jett Button – PUSH
2, 3, 5, 7, and/or 8 (VER, fuel tank, Walleye pod, HARM launcher, Maverick launcher, Sparrow launcher carrying Sparrow or Sidewinder, or individual weapon directly hung on BRU 32/A)	UP ★★	Selective Jettison Knob Jettison Station Select Button(s) & Master Arm Switch	Select Jett Knob – RACK/LCHR Select Jett Station Buttons – PRESS APPROPRIATE BUTTON(S) Master Arm Switch – ARM Select Jett Knob – PUSH
2, 3, 5, 7 and/or 8 (Bombs or rocket launcher on VER , fuel tank, Walleye pod, HARM, Maverick launcher Sparrow launcher carrying Sparrow or Sidewinder, or individual weapon directly hung on BRU–32/A)	UP ★★	Selective Jettison Knob Jettison Station Select Button (s) & Master Arm Switch	Select Jett Knob – STORES Select Jett Station Buttons – PRESS APPROPRIATE BUTTON(S) Master Arm Switch – ARM Select Jett Knob – PUSH

★ Aircraft weight off gear.
★★ Gear must be up and locked for selective jettison.

18AC–NFM–00–(40)A

Figure 5-8. External Stores Jettison Chart

If unable to clear smoke –

4. Slow and jettison canopy
   In TF/A airplanes the rear crewmember should lower the seat and lean as far forward as possible before jettisoning canopy.

If fire present –

1. All electrical equipment - OFF
2. UFC avionics - OFF
   UFC avionics requires ac power to secure.
3. Required electrical equipment - ON
   Restore power to equipment one at a time. If smoke/fire starts again, secure that equipment.

DISPLAY MALFUNCTION

Turn off malfunctioning displays as they may overheat and cause a fire if not functioning correctly. If all displays are flashing, turn MC1 and MC2 off alternately to see if the problem will clear.

EXTERNAL STORES JETTISON

The emergency jettison button, labeled EMERG JETT, on the left edge of the instrument panel, simultaneously jettisons stores from the parent bomb racks on external stores stations 2, 3, 5, 7 and 8. Pressing the button initiates jettison. The emergency jettison button is operational with either the weight off the right main landing gear or the landing gear handle in the UP position. Selective jettison is provided. On the TF/A-18A, an emergency jettison button is installed in the rear cockpit on the upper edge of the instrument panel between the left DDI and the upfront control. Operation is identical to the button in the front cockpit. See figure 5-8 for jettison procedures.

FCS FAILURE INDICATIONS AND EFFECTS (AIRPLANES THRU 161924)

FCS failures are indicated by various cautions and, when selected, by the FCS status display on a DDI. The FCS display should be used to determine the precise failure immediately upon indication of an FCS malfunction. A simultaneous failure of channels 1 and 3 will prevent display of any FCS cautions. The FCS status display will be blank except for the airplane representation where control surface (LEF, TEF, and stabilator) positions are normally shown. Failure of channels 1 and 3 does not affect flying qualities. FCS status displays are shown with the associated FCS cautions as follows:

CHANNEL 1 FAILURE

Cautions (5.3.1 PROM)
FCS 1ST

Cautions (after 7.0 PROM)
FCS

FCS Status Display

CHAN		1	4	2	3
STB	SV1	X X			
	SV2	X X			
TEF	SV1	X X			
	SV2	X X			
RUD		LX	L	R	R
AIL		X			
AOA		X			
LEF	SV1	X			
	SV2	X			
GYRO	P	X			
	R	X			
	Y	X			
FORCE	P	X			
	R	X			
	Y	X			
TRIM	P	X			
	R	X			
	Y	X			
ACCL	NY	X			
	NZ	X			
PROC					
BADS	PS	X			
	QC	X			

Effects

No change in flying qualities.

CHANNEL 4 FAILURE (5.3.1 PROM)

Cautions

FCS 2ND FX GAINS NWS

FCS Status Display

CHAN		1	4	2	3
STB	SV1		X X		
	SV2		X X		
TEF	SV1		X X		
	SV2		X X		
RUD		L	LX	R	R
AIL			X		
AOA			X		
LEF	SV1		X		
	SV2		X		
GYRO	P		X		
	R		X		
	Y		X		
FORCE	P		X		
	R		X		
	Y		X		
TRIM	P		X		
	R		X		
	Y		X		
ACCL	NY		X		
	NZ		X		
PROC					
BADS	PS	X	X	X	X
	QC	X	X	X	X

Effects

Flaps - AUTO
- Degraded flying qualities.
- Flaps freeze.
- If reset fails, flaps go to 0°/0°.

Flaps - HALF or FULL
- Trailing edge flaps 30° or 45°. Reset will not change position.
- Leading edge flaps and rudders schedule with AOA.
- Nosewheel steering inoperative.

CHANNEL 4 FAILURE (AFTER 7.0 PROM)

Cautions

FCS NWS

FCS Status Display

CHAN		1	4	2	3
STB	SV1		X X		
	SV2		X X		
TEF	SV1		X X		
	SV2		X X		
RUD		L	LX	R	R
AIL			X		
AOA			X		
LEF	SV1		X		
	SV2		X		
GYRO	P		X		
	R		X		
	Y		X		
FORCE	P		X		
	R		X		
	Y		X		
TRIM	P		X		
	R		X		
	Y		X		
ACCL	NY		X		
	NZ		X		
PROC					
BADS	PS		X		
	QC		X		

Effects

ATC inoperative.

Nosewheel steering inoperative on airplanes thru 161528.

Emergency high gain nosewheel steering with channel 4 cb pulled, wings unlocked, and NWS button pressed on airplanes 161702 and up.

CHANNEL 2 FAILURE (5.3.1 PROM)

Cautions

FCS 2ND FX GAINS NWS

FCS Status Display

CHAN		1	4	2	3
STB	SV1			X X	
	SV2			X X	
TEF	SV1			X X	
	SV2			X X	
RUD		L	L	RX	R
AIL				X	
AOA				X	
LEF	SV1			X	
	SV2			X	
GYRO	P			X	
	R			X	
	Y			X	
FORCE	P			X	
	R			X	
	Y			X	
TRIM	P			X	
	R			X	
	Y			X	
ACCL	NY			X	
	NZ			X	
PROC					
BADS	PS	X	X	X	X
	QC	X	X	X	X

Effects

- Flaps - AUTO
  - Degraded flying qualities.
  - Flaps freeze.
  - If reset fails, flaps go to 0°/0°.
- Flaps - HALF or FULL
  - Trailing edge flaps 30° to 45°. Reset will not change position.
  - Leading edge flaps and rudders schedule with AOA.
  - Nosewheel steering inoperative.

CHANNEL 2 FAILURE (AFTER 7.0 PROM)

Cautions

FCS NWS

FCS Status Display

CHAN		1	4	2	3
STB	SV1			X X	
	SV2			X X	
TEF	SV1			X X	
	SV2			X X	
RUD		L	L	RX	R
AIL				X	
AOA				X	
LEF	SV1			X	
	SV2			X	
GYRO	P			X	
	R			X	
	Y			X	
FORCE	P			X	
	R			X	
	Y			X	
TRIM	P			X	
	R			X	
	Y			X	
ACCL	NY			X	
	NZ			X	
PROC					
BADS	PS			X	
	QC			X	

Effects

ATC inoperative.

Nosewheel steering inoperative on airplanes thru 161528.

Emergency high gain nosewheel steering with channel 2 cb pulled, wings unlocked, and NWS button pressed on airplanes 161702 and up.

CHANNEL 3 FAILURE

Cautions (5.3.1 PROM)
FCS 1ST

Cautions (after 7.0 PROM)
FCS

FCS Status Display

CHAN		1	4	2	3
STB	SV1				X X
	SV2				X X
TEF	SV1				X X
	SV2				X X
RUD		L	L	R	RX
AIL					X
AOA					X
LEF	SV1				X
	SV2				X
GYRO	P				X
	R				X
	Y				X
FORCE	P				X
	R				X
	Y				X
TRIM	P				X
	R				X
	Y				X
ACCL	NY				X
	NZ				X
PROC					
BADS	PS				X
	QC				X

Effects

No change in flying qualities.

CHANNEL 1 & 4 FAILURE (5.3.1 PROM)

Cautions
FCS 2ND FX GAINS NWS

FCS Status Display

CHAN		1	4	2	3
STB	SV1	X X	X X		
	SV2	X X	X X		
TEF	SV1	X X	X X		
	SV2	X X	X X		
RUD		LX	LX	R	R
AIL		X	X		
AOA		X	X	X	X
LEF	SV1	X	X		
	SV2	X	X		
GYRO	P	X	X		
	R	X	X		
	Y	X	X		
FORCE	P	X	X		
	R	X	X		
	Y	X	X		
TRIM	P	X	X		
	R	X	X		
	Y	X	X		
ACCL	NY	X	X		
	NZ	X	X		
PROC					
BADS	PS	X	X	X	X
	QC	X	X	X	X

Effects

Left aileron and left rudder failed (flutter damped).

Flaps - AUTO
Flaps freeze.
If reset fails, flaps go to 0°/0°.

Flaps - HALF
Lead edge flaps 30°.
Trailing edge flaps 30°.
No aileron droop.
No rudder toe-in.
Nosewheel steering inoperative.

CHANNELS 1 & 4 FAILURE (AFTER 7.0 PROM)

Cautions

FCS AIL OFF RUD OFF FLAPS OFF NWS

FCS Status Display

CHAN		1	4	2	3
STB	SV1	X X	X X		
	SV2	X X	X X		
TEF	SV1	X X	X X		
	SV2	X X	X X		
RUD		LX	LX	R	R
AIL		X	X		
AOA		X	X	X	X
LEF	SV1	X	X		
	SV2	X	X		
GYRO	P	X	X		
	R	X	X		
	Y	X	X		
FORCE	P	X	X		
	R	X	X		
	Y	X	X		
TRIM	P	X	X		
	R	X	X		
	Y	X	X		
ACCL	NY	X	X		
	NZ	X	X		
PROC					
BADS	PS	X	X		
	QC	X	X		

Effects

Left leading edge flap locked in failed position.

Left aileron and left rudder failed (flutter damped).

Autopilot and ATC inoperative.

Flaps - AUTO

Flaps freeze.

Flaps - HALF

Right leading edge flap scheduled with air data.

Trailing edge flaps 30° maximum scheduled with airspeed.

No aileron droop.

No rudder toe-in.

Nosewheel steering inoperative on airplanes thru 161528.

Emergency high gain nosewheel steering with channel 4 cb pulled, wings unlocked, and NWS button pressed on airplanes 161702 and up.

CHANNELS 1 & 2 FAILURE (5.3.1 PROM)

Cautions

FCS 2ND FX GAINS NWS

FCS Status Display

CHAN		1	4	2	3
STB	SV1	X X		X X	
	SV2	X X		X X	
TEF	SV1	X X		X X	
	SV2	X X		X X	
RUD		LX	L	RX	R
AIL		X		X	
AOA		X		X	
LEF	SV1	X		X	
	SV2	X		X	
GYRO	P	X		X	
	R	X		X	
	Y	X		X	
FORCE	P	X		X	
	R	X		X	
	Y	X		X	
TRIM	P	X		X	
	R	X		X	
	Y	X		X	
ACCL	NY	X		X	
	NZ	X		X	
PROC					
BADS	PS	X	X	X	X
	QC	X	X	X	X

Effects

Flaps - AUTO

Degraded flying qualities.

Flaps freeze.

If reset fails, flaps go to 0°/0°.

Flaps - HALF or FULL

Trailing edge flaps 30, or 45°, reset will not change position.

Leading edge flaps and rudders schedule with AOA.

Nosewheel steering inoperative.

CHANNELS 1 & 2 FAILURE (AFTER 7.0 PROM)

Cautions

FCS NWS

FCS Status Display

CHAN		1	4	2	3
STB	SV1	X X		X X	
	SV2	X X		X X	
TEF	SV1	X X		X X	
	SV2	X X		X X	
RUD		LX	L	RX	R
AIL		X		X	
AOA		X		X	
LEF	SV1	X		X	
	SV2	X		X	
GYRO	P	X		X	
	R	X		X	
	Y	X		X	
FORCE	P	X		X	
	R	X		X	
	Y	X		X	
TRIM	P	X		X	
	R	X		X	
	Y	X		X	
ACCL	NY	X		X	
	NZ	X		X	
PROC					
BADS	PS	X		X	
	QC	X		X	

Effects

Autopilot inoperative.
Nosewheel steering inoperative on airplanes thru 161528.
Emergency high gain nosewheel steering with channel 2 cb pulled, wings unlocked, and NWS button pressed on airplanes 161702 and up.

CHANNELS 1 & 3 FAILURE

An exactly simultaneous failure of channels 1 and 3 will prevent display of any FCS cautions. The FCS display will be blank except for the airplane representation where control surface (LEF, TEF, and stabilator) positions are normally shown.

Cautions (5.3.1 PROM)

FCS 2ND

Cautions (after 7.0 PROM)

FCS

FCS Status Display

CHAN		1	4	2	3
STB	SV1	X X			X X
	SV2	X X			X X
TEF	SV1	X X			X X
	SV2	X X			X X
RUD		LX	L	R	RX
AIL		X			X
AOA		X			X
LEF	SV1	X			X
	SV2	X			X
GYRO	P	X			X
	R	X			X
	Y	X			X
FORCE	P	X			X
	R	X			X
	Y	X			X
TRIM	P	X			X
	R	X			X
	Y	X			X
ACCL	NY	X			X
	NZ	X			X
PROC					
BADS	PS	X			X
	QC	X			X

Effects

No change in flying qualities.

CHANNELS 3 & 4 FAILURE (5.3.1 PROM)

Cautions

FCS 2ND FX GAINS NWS

FCS Status Display

CHAN		1	4	2	3
STB	SV1		X X		X X
	SV2		X X		X X
TEF	SV1		X X		X X
	SV2		X X		X X
RUD		L	LX	R	RX
AIL			X		X
AOA			X		X
LEF	SV1		X		X
	SV2		X		X
GYRO	P		X		X
	R		X		X
	Y		X		X
FORCE	P		X		X
	R		X		X
	Y		X		X
TRIM	P		X		X
	R		X		X
	Y		X		X
ACCL	NY		X		X
	NZ		X		X
PROC					
BADS	PS	X	X	X	X
	QC	X	X	X	X

Effects

Flaps - AUTO

Degraded flying qualities.

Flaps freeze.

If reset fails, flaps go to 0°/0°.

Flaps - HALF or FULL

Trailing edge flaps 30° or 45°.

Leading edge flaps and rudders schedule with AOA.

Nosewheel steering failed.

CHANNELS 3 & 4 FAILURE (AFTER 7.0 PROM)

Cautions

FCS NWS

FCS Status Display

CHAN		1	4	2	3
STB	SV1		X X		X
	SV2		X X		X X
TEF	SV1		X X		X X
	SV2		X X		X X
RUD		L	LX	R	RX
AIL			X		X
AOA			X		X
LEF	SV1		X		X
	SV2		X		X
GYRO	P		X		X
	R		X		X
	Y		X		X
FORCE	P		X		X
	R		X		X
	Y		X		X
TRIM	P		X		X
	R		X		X
	Y		X		X
ACCL	NY		X		X
	NZ		X		X
PROC					
BADS	PS		X		X
	QC		X		X

Effects

Autopilot and ATC inoperative.

Nosewheel steering inoperative on airplanes thru 161528.

Emergency high gain nosewheel steering with channel 4 cb pulled, wings unlocked, and NWS button pressed on airplanes 161702 and up.

CHANNELS 2 & 4 FAILURE

Cautions (5.3.1 PROM)

FCS 2ND FX GAINS NWS

Cautions (after 7.0 PROM)

FCS FC AIR DAT FLAP SCHED NWS

FCS Status Display

CHAN		1	4	2	3
STB	SV1		X X	X X	
	SV2		X X	X X	
TEF	SV1		X X	X X	
	SV2		X X	X X	
RUD		L	LX	RX	R
AIL			X	X	
AOA			X	X	
LEF	SV1		X	X	
	SV2		X	X	
GYRO	P		X	X	
	R		X	X	
	Y		X	X	
FORCE	P		X	X	
	R		X	X	
	Y		X	X	
TRIM	P		X	X	
	R		X	X	
	Y		X	X	
ACCL	NY		X	X	
	NZ		X	X	
PROC					
BADS	PS	X	X	X	X
	QC	X	X	X	X

Effects

Autopilot and ATC inoperative.

Flaps - AUTO

Degraded flying qualities.

Flaps freeze (at high speed only with 7.0 PROM).

After 7.0 PROM, flaps schedule with AOA at low speed.

With 5.3.1 PROM, if reset fails, flaps go to 0°/0°.

Flaps - HALF or FULL

Trailing edge flaps 30° or 45°; with 5.3.1 PROM, reset will not change position.

Leading edge flaps and rudder schedule with AOA.

Nosewheel steering inoperative.

CHANNELS 2 & 3 FAILURE (5.3.1 PROM)

Cautions

FCS 2ND FX GAINS NWS

FCS Status Display

CHAN		1	4	2	3
STB	SV1			X X	X X
	SV2			X X	X X
TEF	SV1			X X	X X
	SV2			X X	X X
RUD		L	L	RX	RX
AIL				X	X
AOA		X	X	X	X
LEF	SV1			X	X
	SV2			X	X
GYRO	P			X	X
	R			X	X
	Y			X	X
FORCE	P			X	X
	R			X	X
	Y			X	X
TRIM	P			X	X
	R			X	X
	Y			X	X
ACCL	NY			X	X
	NZ			X	X
PROC					
BADS	PS	X	X	X	X
	QC	X	X	X	X

Effects

Right aileron and right rudder failed (flutter damped).

Flaps - AUTO

Flaps freeze.

If reset fails, flaps go to 0°/0°.

Flaps - HALF

Leading edge flaps 30°.

Trailing edge flaps 30°.

No aileron droop.

No rudder toe-in.

Nosewheel steering failed.

CHANNELS 2 & 3 FAILURE (AFTER 7.0 PROM)

Cautions

FCS AIL OFF RUD OFF
FLAPS OFF NWS

FCS Status Display

CHAN		1	4	2	3
STB	SV1			X X	X X
	SV2			X X	X X
TEF	SV1			X X	X X
	SV2			X X	X X
RUD		L	L	RX	RX
AIL				X	X
AOA		X	X	X	X
LEF	SV1			X	X
	SV2			X	X
GYRO	P			X	X
	R			X	X
	Y			X	X
FORCE	P			X	X
	R			X	X
	Y			X	X
TRIM	P			X	X
	R			X	X
	Y			X	X
ACCL	NY			X	X
	NZ			X	X
PROC					
BADS	PS			X	X
	QC			X	X

Effects

Degraded flying qualities.
Right leading edge flap locked in failed position.
Right aileron and right rudder failed (flutter damped).
Autopilot and ATC inoperative.

Flaps - AUTO
Flaps freeze.

Flaps - HALF
Left leading edge flap scheduled with air data.
Trailing edge flaps 30° maximum scheduled with airspeed.
No aileron droop.
No rudder toe-in.
Nosewheel steering inoperative on airplanes thru 161528.
Emergency high gain nosewheel steering with channel 2 cb pulled, wings unlocked, and NWS button pressed on airplanes 161702 and up.

ACTUATOR SINGLE ELECTRICAL FAILURE

Cautions (5.3.1 PROM)

FCS 1ST

Cautions (after 7.0 PROM)

FCS

FCS Status Display

CHAN		1	4	2	3
STB	SV1	X *	* *	* *	
	SV2	X *	* *	* *	
TEF	SV1	* *	* *	* *	
	SV2	* *	* *	* *	
RUD		L	L	R	R
AIL					
AOA					
LEF	SV1	* *	* *		
	SV2	* *	* *		
GYRO	P				
	R				
	Y				
FORCE	P				
	R				
	Y				
TRIM	P				
	R				
	Y				
ACCL	NY				
	NZ				
PROC					
BADS	PS				
	QC				

* FCS status display is shown for left stabilator channel 1 but is typical for any channel of stabilator, trailing edge flap, or leading edge flap.

Effects

No change in flying qualities. Two more electrical failures will cause actuator to revert to degraded mode.

ACTUATOR SINGLE SERVO VALVE FAILURE

Cautions (5.3.1 PROM)

FCS 2ND

Cautions (after 7.0 PROM)

FCS

FCS Status Display

CHAN		1	4	2	3
STB	SV1	* *	* *	* *	* *
	SV2	* X	* X	* X	* X
TEF	SV1	* *	* *	* *	* *
	SV2				
RUD		L	L	R	R
AIL					
AOA					
LEF	SV1	* *	* *	* *	* *
	SV2	* *	* *	* *	* *
GYRO	P				
	R				

* FCS Status Display is shown for right stabilator servo valve 2 failure but is typical for either servo valve of stabilator, leading edge flap, or trailing edge flap.

Effects

No change in flying qualities. One more servo valve failure or three electrical failures will cause actuator to revert to degraded mode.

STABILATOR ACTUATOR BOTH SERVO VALVES 4 CHANNEL FAILURE

Cautions

FCS MECH ON

FCS Status Display

CHAN		1	4	2	3
STB	SV1	X X	X X	X X	X X
	SV2	X X	X X	X X	X X
TEF	SV1				
	SV2				
RUD					

Effects

Stabilators in mechanical backup (MECH) mode. Refer to MECH ON Caution procedure, this section.

PITCH FORCE 4 CHANNEL FAILURE (5.3.1 PROM) PITCH POSITION 4 CHANNEL FAILURE (AFTER 7.0 PROM)

Cautions

FCS MECH ON

FCS Status Display

CHAN		1	4	2	3
STB	SV1	X X	X X	X X	X X
	SV2	X X	X X	X X	X X
TEF	SV1				
	SV2				
RUD		L	L	R	R
AIL					
AOA					
LEF	SV1				
	SV2				
GYRO	P				
	R				
	Y				
FORCE	P	X	X	X	X
	R				
	Y				
TRIM	P				
	R				
	Y				
ACCL	NY				
	NZ				
PROC					
BADS	PS				
	QC				

Effects

Stabilators in mechanical backup (MECH) mode. Refer to MECH ON Caution procedure, this section.

ROLL FORCE 4 CHANNEL FAILURE (5.3.1 PROM) ROLL POSITION 4 CHANNEL FAILURE (AFTER 7.0 PROM)

Caution

FCS MECH ON

FCS Status Display

CHAN		1	4	2	3
STB	SV1	X X	X X	X X	X X
	SV2	X X	X X	X X	X X
TEF	SV1				
	SV2				
RUD		L	L	R	R
AIL					
AOA					
LEF	SV1				
	SV2				
GYRO	P				
	R				
	Y				
FORCE	P				
	R	X	X	X	X
	Y				
TRIM	P				
	R				
	Y				
ACCL	NY				
	NZ				
PROC					
BADS	PS				
	QC				

Effects

Stabilators in mechanical backup (MECH) mode. Refer to MECH ON Caution procedure, this section.

TRAILING EDGE FLAPS BOTH SERVO VALVES 4 CHANNEL FAILURE

Cautions (5.3.1 PROM)

FCS 2ND FLAPS OFF

Cautions (after 7.0 PROM)

FCS FLAPS OFF

FCS Status Display

CHAN		1	4	2	3
STB	SV1				
	SV2				
TEF	SV1	X X	X X	X X	X X
	SV2	X X	X X	X X	X X
RUD					

Effects

Autopilot and ATC inoperative.

Flaps - AUTO

Leading edge flaps schedule with AOA.

Trailing edge flaps hydraulically driven to 0°.

Flaps - HALF or FULL

Leading edge flaps schedule with AOA.

Trailing edge flaps hydraulically driven to 0°.

No aileron droop.

RUDDER CHANNELS 1 & 2 or 3 & 4 FAILURE

Cautions (5.3.1 PROM)

FCS 2ND

Cautions (after 7.0 PROM)

FCS

FCS Status Display

TEF	SV1				
	SV2				
RUD		L X	L *	R X	R *
AIL					
AOA					
LEF	SV1				

* Channel 1 & 2 failure shown.

Effects

No change in flying qualities.

RUDDER CHANNELS 1 & 4 or 2 & 3 FAILURE

Cautions (5.3.1 PROM)
FCS 2ND

Cautions (after 7.0 PROM)
FCS RUD OFF

FCS Status Display

TEF	SV1				
	SV2				
RUD		L X	L X	R *	R *
AIL					
AOA					
LEF	SV1				

* Channels 1 & 4 failure shown.

Effects

Left rudder (channels 1 and 4) failed (flutter damped) or
Right rudder (channels 2 and 3) failed (flutter damped).
Directional control critical with one engine out.
Autopilot inoperative.

Flaps - HALF or FULL
No rudder toe-in.

AILERON CHANNELS 1 & 2 OR 3 & 4 FAILURE

Cautions (5.3.1 PROM)
FCS 2ND

Cautions (after 7.0 PROM)
FCS

FCS Status Display

TEF	SV1				
	SV2				
RUD		L	L	R	R
AIL		X	*	X	*
AOA					
LEF	SV1				

* Channels 1 & 2 failure shown.

Effects

No change in flying qualities.

AILERON CHANNELS 1 & 4 or 2 & 3 FAILURE

Cautions (5.3.1 PROM)
FCS 2ND

Cautions (after 7.0 PROM)
FCS AIL OFF

FCS Status Display

TEF	SV1				
	SV2				
RUD		L	L	R	R
AIL		X	X	*	*
AOA					
LEF	SV1				

* Channels 1 & 4 failure shown.

Effects

Left aileron (channels 1 and 4) failed (flutter damped) or
Right aileron (channels 2 and 3) failed.
Autopilot inoperative.
Flaps - HALF
No aileron droop.
Trailing edge flaps 30° maximum. Scheduled with airspeed.
Leading edge flaps and rudders schedule normally.

AOA 4 CHANNEL FAILURE

Cautions (5.3.1 PROM)
FCS 2ND FX GAINS

Cautions (after 7.0 PROM)
FCS FLAP SCHED

FCS Status Display

TEF	SV1				
	SV2				
RUD		L	L	R	R
AIL					
AOA		X	X	X	X
LEF	SV1				

Effects

Autopilot inoperative.
Flaps - AUTO
With 5.3.1 PROM, flaps freeze.
With 5.3.1 PROM, if reset fails, flaps go to 0°/0°.
After 7.0 PROM, flaps schedule with airspeed only.
After 7.0 PROM, flaps go to 3°/3° if ORIDE selected.
Flaps - HALF or FULL
Normal flying qualities.
Trailing edge flaps 30° or 45° maximum scheduled with airspeed.
Leading edge flaps and rudders schedule with air data (simulated AOA).

AOA AND BACKUP AIR DATA SENSORS 4 CHANNEL FAILURE

Cautions (5.3.1 PROM)
FCS 2ND FX GAINS

Cautions (after 7.0 PROM)
FCS FLAP SCHED FC AIR DAT

FCS Status Display

TEF	SV1				
	SV2				
RUD		L	L	R	R
AIL					
AOA		X	X	X	X
LEF	SV1				
	SV2				
GYRO	P				
	R				
	Y				
FORCE	P				
	R				
	Y				
TRIM	P				
	R				
	Y				
ACCL	NY				
	NZ				
PROC					
BADS	PS	X	X	X	X
	QC	X	X	X	X

Effects

- Pitot-static instruments may be inaccurate.
- Autopilot inoperative.

Flaps - AUTO

- Degraded flying qualities.
- Flaps freeze.
- With 5.3.1 PROM if reset fails, flaps go to 0°/0°.
- After 7.0 PROM, with ORIDE selected flaps go to 3°/3°.

Flaps - HALF or FULL

- No rudder toe-in.
- With 5.3.1 PROM, flaps 30°/30° or 30°/45°.
- After 7.0 PROM, flaps freeze.
- After 7.0 PROM, flaps go to 17°/30° or 17°/45° if ORIDE selected.

LEADING EDGE FLAPS BOTH SERVO VALVES 4 CHANNEL FAILURE

Cautions (5.3.1 PROM)
FCS 2ND FLAPS OFF

Cautions (after 7.0 PROM)
FCS FLAPS OFF

FCS Status Display

AOA					
LEF	SV1	X	X	X	X
	SV2	X	X	X	X
GYRO	P				

Effects

- Autopilot inoperative

Flaps - AUTO

- Degraded flying qualities.
- Leading edge flaps locked in position at failure.
- Trailing edge flaps freeze.
- With 5.3.1 PROM if reset fails, trailing edge flaps go to 0°.

Flaps - HALF or FULL

- Leading edge flaps locked in position at failure.
- With 5.3.1 PROM, trailing edge flaps 30°/45°. Reset will not change position.
- After 7.0 PROM, trailing edge flaps 30°/45° maximum, scheduled with airspeed.

GYRO 2 CHANNEL FAILURE

Cautions (5.3.1 PROM)
FCS 2ND

Cautions (after 7.0 PROM)
FCS

FCS Status Display

LEF	SV1				
	SV2				
GYRO	P	X	*	X	*
	R	*	*	*	*
	Y	*	*	*	*
FORCE	P				

* Pitch rate gyro channels 1 & 2 failure shown.

Effects

No change in flying qualities.
Autopilot inoperative.

PITCH RATE GYRO 4 CHANNEL FAILURE

Cautions (5.3.1 PROM)
P DEL ON

Cautions (after 7.0 PROM)
FCS DEL ON

FCS Status Display

LEF	SV1				
	SV2				
GYRO	P	X	X	X	X
	R				
	Y				
FORCE	P				

Effects

Pitch in direct electrical link (DEL) mode.
No pitch augmentation.
Autopilot and ATC inoperative.

Flaps - AUTO
Poor pitch stability.
Excessive speed brake transient.

ROLL RATE GYRO 4 CHANNEL FAILURE

Cautions (5.3.1 PROM)
R DEL ON

Cautions (after 7.0 PROM)
FCS DEL ON

FCS Status Display

	SV2				
GYRO	P				
	R	X	X	X	X
	Y				
FORCE	P				

Effects

Roll in direct electrical link (DEL) mode.
No roll augmentation.
Reduced roll damping.
Autopilot and ATC inoperative.

YAW RATE GYRO 4 CHANNEL FAILURE

Cautions (5.3.1 PROM)
R DEL ON Y DEL ON

Cautions (after 7.0 PROM)
FCS DEL ON

FCS Status Display

	SV2				
GYRO	P				
	R				
	Y	X	X	X	X
FORCE	P				

Effects

Roll and yaw in direct electrical link (DEL) mode.
No roll and yaw augmentation.
Autopilot and ATC inoperative.

Flaps - AUTO
Poor dutch roll damping.
Poor turn coordination.

Flaps - HALF
Poor dutch roll damping.
Poor turn coordination.

YAW FORCE 4 CHANNEL FAILURE

Cautions (5.3.1 PROM)
FCS 2ND NWS

Cautions (after 7.0 PROM)
FCS NWS

FCS Status Display

	Y				
FORCE	P				
	R				
	Y	X	X	X	X
TRIM	P				

Effects

No rudder pedal control of rudders.
Nosewheel steering inoperative.
Trim gives 15° rudder.
Lateral stick gives rudder for roll coordination.

PITCH TRIM 4 CHANNEL FAILURE

Cautions (5.3.1 PROM)
FCS 2ND

Cautions (after 7.0 PROM)
FCS

FCS Status Display

	Y				
TRIM	P	X	X	X	X
	R				
	Y				
ACCL	NY				

Effects

No manual trim.
Flaps - AUTO
Maintains 1G trim.
Flaps - HALF or FULL
If failed in AUTO, trimmed for 0° AOA.
If failed in HALF or FULL, holds last trim.

ROLL TRIM 4 CHANNEL FAILURE

Cautions (5.3.1 PROM)
FCS 2ND

Cautions (after 7.0 PROM)
FCS

FCS Status Display

	Y				
TRIM	P				
	R	X	X	X	X
	Y				
ACCL	NY				

Effects

No roll trim.

YAW TRIM 4 CHANNEL FAILURE

Cautions (5.3.1 PROM)
FCS 2ND

Cautions (after 7.0 PROM)
FCS

FCS Status Display

	Y				
TRIM	P				
	R				
	Y	X	X	X	X
ACCL	NY				

Effects

No yaw trim.

LATERAL ACCELEROMETER (NY) 4 CHANNEL FAILURE

Cautions (5.3.1 PROM)
R DEL ON Y DEL ON

Cautions (after 7.0 PROM)
FCS

FCS Status Display

	Y				
ACCL	NY	X	X	X	X
	NZ				
PROC					
BADS	PS				

Effects (5.3.1 PROM)

Roll and yaw in direct electrical link (DEL) mode.
No roll and yaw augmentation..
Flaps - AUTO
High speed roll response abrupt and jerky.
High frequency buzz with sustained roll input.
Flaps - HALF
Poor dutch roll damping.

Effects (after 7.0 PROM)

Degraded yaw CAS.
Poor turn coordination.
Autopilot inoperative.

ACCELEROMETER 2 CHANNEL FAILURE

Cautions (5.3.1 PROM)
FCS 2ND

Cautions (after 7.0 PROM)
FCS

FCS Status Display

	Y				
ACCL	NY	X	*	X	*
	NZ	*	*	*	*
PROC					
BADS	PS				

* Channels 1 & 2 failure shown.

Effects

No change in flying qualities.
Autopilot inoperative.

NORMAL ACCELEROMETER (NZ) 4 CHANNEL FAILURE

Cautions (5.3.1 PROM)
P DEL ON

Cautions (after 7.0 PROM)
FCS DEL ON (flaps AUTO)
FCS (flaps HALF or FULL)

FCS Status Display

	Y				
ACCL	NY				
	NZ	X	X	X	X
PROC					
BADS	PS				

Effects

With 5.3.1 PROM, pitch in DEL mode.
After 7.0 PROM, pitch in DEL mode with flaps AUTO; in CAS mode with flaps HALF or FULL.
Autopilot and ATC inoperative.
Flaps - AUTO
Poor pitch stability.
Excessive speed brake transient.

PROCESSOR 4 CHANNEL FAILURE

Cautions

Processor 4 channel failure will cause many random FCS cautions.

FCS Status Display

	R				
	Y				
ACCL	NY				
	NZ				
PROC		X	X	X	X
BADS	PS				
	QC				

Effects

If software fault recovery process can clear fault -

No Effect

If complete processor 4 channel failure -

DDI blank except for stick airplane. No control positions shown.

Stabilators revert to mechanical (MECH) mode.

Ailerons and rudders revert to analog direct electrical link.

Trailing edge flaps drive to 0°.

Leading edge flaps lock in position at failure.

BACKUP AIR DATA SENSORS 4 CHANNEL FAILURE

Cautions (5.3.1 PROM)

FCS 2ND FX GAINS

Cautions (after 7.0 PROM)

FCS FLAPS SCHED FC AIR DAT

FCS Status Display

PROC					
BADS	PS	X	X	X	X
	QC	X	X	X	X

Effects

Pitot-static instruments may be inaccurate.

Autopilot inoperative.

Flaps - AUTO

Degraded flying qualities.

With 5.3.1 PROM, flaps freeze.

With 5.3.1 PROM, if reset fails, flaps go to 0°/0°.

After 7.0 PROM, flaps schedule with AOA only.

After 7.0 PROM, flaps go to 3°/3° if ORIDE selected.

Flaps - HALF or FULL

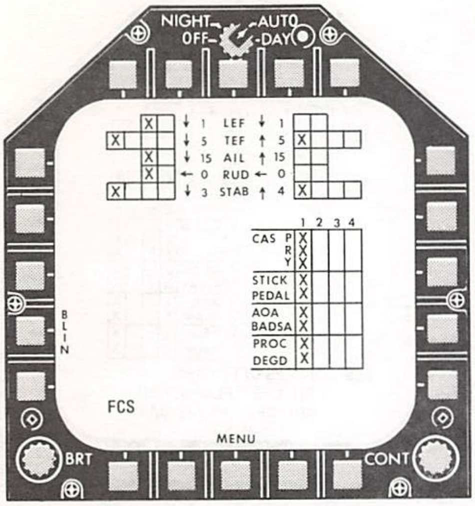
Trailing edge flaps 30° or 45°.

Leading edge flaps and rudders schedule with AOA.

FCS FAILURE INDICATIONS AND EFFECTS (AIRPLANES 161925 AND UP)

FCS failures are indicated by various cautions and when selected, the FCS status display on a DDI. The FCS display should be used to determine the precise failure immediately upon indication of an FCS malfunction. A simultaneous failure of channels 1 and 3 will prevent display of any FCS cautions. The FCS status display will not show any failure indications nor control positions. The word **INVALID** will appear near the center of the DDI. Failure of channels 1 and 3 does not affect flying qualities. FCS status displays are shown as follows:

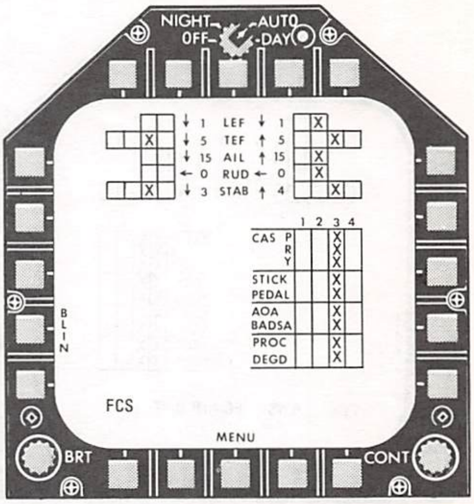
CHANNEL 1 FAILURE



Effects:

No change in flying qualities.

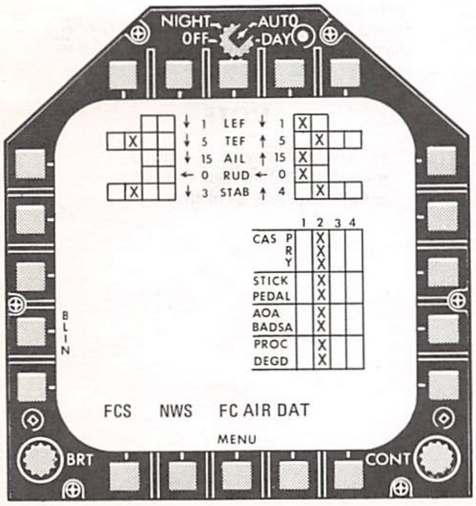
CHANNEL 3 FAILURE



Effects:

No change in flying qualities.

CHANNEL 2 FAILURE



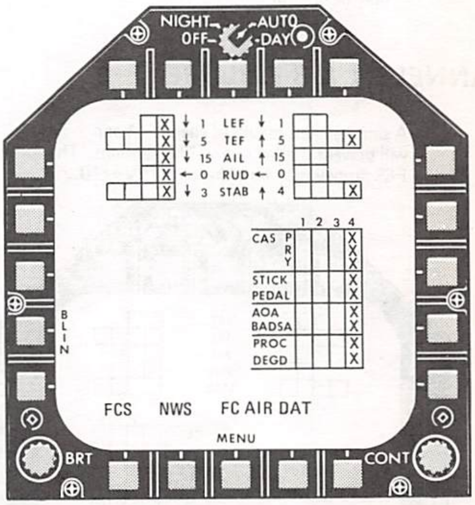
Effects:

ATC inoperative.
Emergency high gain nosewheel steering with channel 2 cb pulled, wings unlocked and nosewheel steering button pressed.

NOTE

FC AIR DAT may not appear. If present, those functions scheduled with air data may be in error.

CHANNEL 4 FAILURE



Effects:

ATC inoperative.
Emergency high gain nosewheel steering with channel 4 cb pulled, wings unlocked, and nosewheel steering button pressed.

NOTE

FC AIR DAT may not appear. If present, those functions scheduled with air data may be in error.

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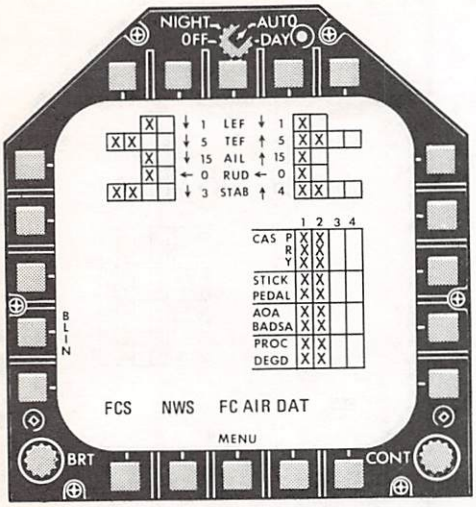
Figure 5-8A. FCD Failure Indications and Effects (Sheet 1 of 9)

CHANNELS 1 & 2 FAILURE



Effects:

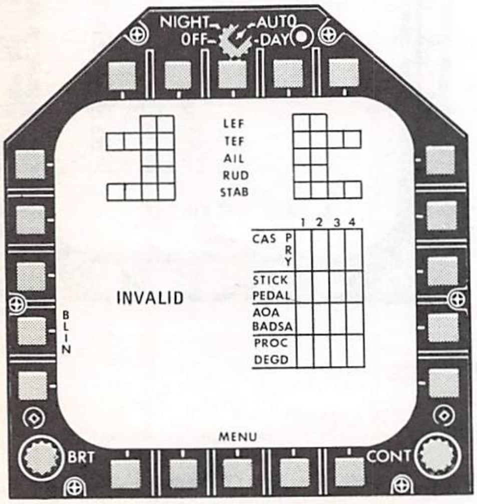
Autopilot inoperative.
Emergency high gain nosewheel steering with channel 2 cb pulled, wings unlocked, and NWS button pressed.

NOTE

FC AIR DAT may not appear. If present, those functions scheduled with air data may be in error.

CHANNELS 1 & 3 FAILURE

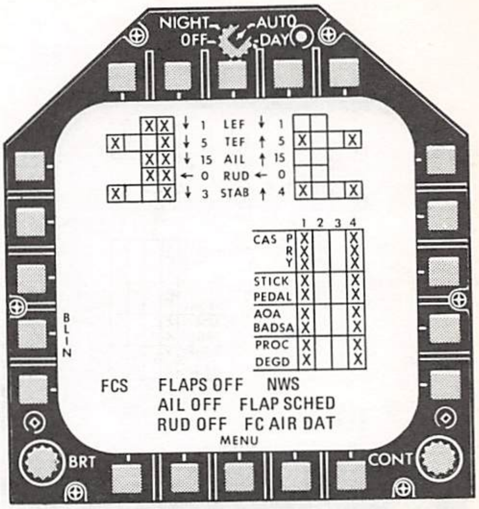
A simultaneous failure of channels 1 and 3 will prevent display of any FCS cautions. The FCS display will show the word INVALID.



Effects:

No change in flying qualities.

CHANNELS 1 & 4 FAILURE



Effects:

Left leading edge flap locked in failed position.
Left aileron and left rudder failed (flutter damped).
Autopilot and ATC inoperative.

Flaps - AUTO
- Flaps freeze.

Flaps - HALF
- Right leading edge flap scheduled with air data.
- Trailing edge flaps 30° maximum. Scheduled with airspeed.
- No aileron droop.
- No rudder toe-in.
- Emergency high gain nosewheel steering with channel 4 cb pulled, wings unlocked, and NWS button pressed.

NOTE

FC AIR DAT may not appear. If present, those functions scheduled with air data may be in error.

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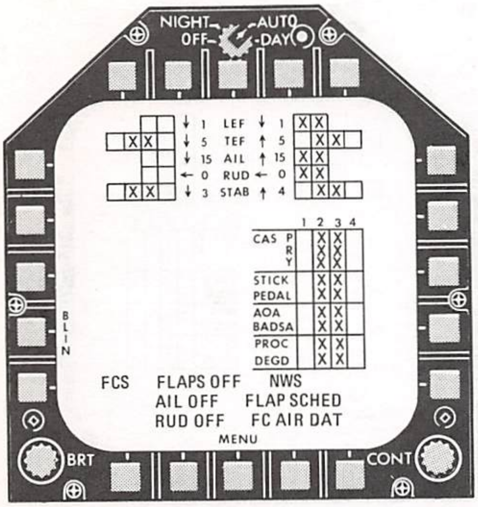
Figure 5-8A. FCS Failure Indications and Effects (Sheet 2)

CHANNELS 2 & 3 FAILURE



				↓ 1	LEF	↓ 1	X	X		
	X	X		↓ 5	TEF	↑ 5		X	X	
				↓ 15	AIL	↑ 15	X	X		
				← 0	RUD	← 0	X	X		
	X	X		↓ 3	STAB	↑ 4		X	X	

		1	2	3	4
CAS	P		X	X	
	R		X	X	
	Y		X	X	
STICK			X	X	
PEDAL			X	X	
AOA			X	X	
BADSA			X	X	
PROC			X	X	
DEGD			X	X	

Effects:

Right leading edge flap locked in failed position.
Right aileron and right rudder failed (flutter damped).
Autopilot and ATC inoperative.

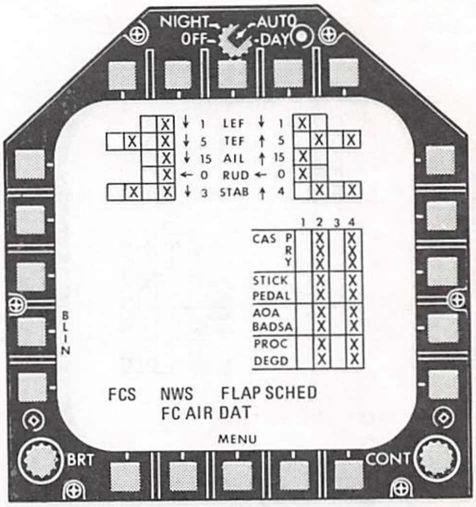
Flaps – AUTO
Flaps freeze.

Flaps – HALF
Left leading edge flap scheduled with air data.
Trailing edge flaps 30° maximum. Scheduled with airspeed.
No aileron droop.
No rudder toe–in.
Emergency high gain nosewheel steering with channel 2 cb pulled, wings unlocked, and NWS button pressed.

NOTE

FC AIR DAT may not appear. If present, those functions scheduled with air data may be in error.

CHANNELS 2 & 4 FAILURE



			X	↓ 1	LEF	↓ 1	X			
	X		X	↓ 5	TEF	↑ 5		X		X
			X	↓ 15	AIL	↑ 15	X			
			X	← 0	RUD	← 0	X			
	X		X	↓ 3	STAB	↑ 4		X		X

		1	2	3	4
CAS	P		X		X
	R		X		X
	Y		X		X
STICK			X		X
PEDAL			X		X
AOA			X		X
BADSA			X		X
PROC			X		X
DEGD			X		X

Effects:

Autopilot and ATC inoperative.

Flaps – AUTO
Degraded flying qualities.
Flaps function with frozen air data values.
Flaps schedule with AOA.

Flaps – HALF or FULL
Trailing edge flaps 30° or 45°.
Leading edge flaps and rudder schedule with AOA.
Nosewheel steering inoperative.

NOTE

FC AIR DAT may not appear. If present, those functions scheduled with air data may be in error.

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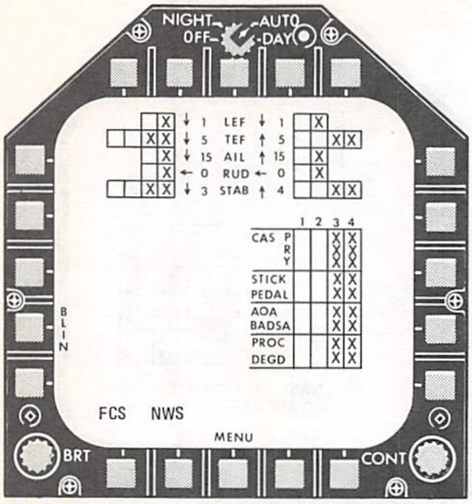
Figure 5-8A. FCS Failure Indications and Effects (Sheet 3)

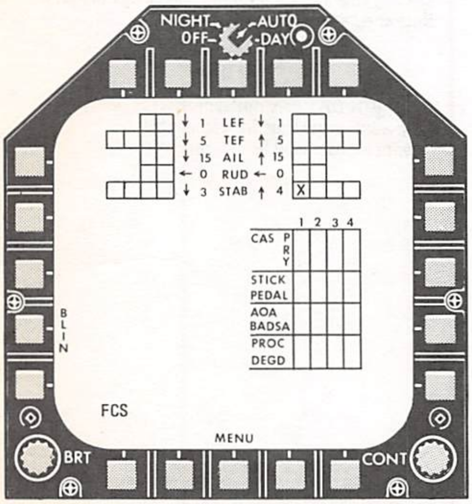
CHANNELS 3 & 4 FAILURE



Effects:

Autopilot and ATC inoperative
Emergency high gain nosewheels steering with channel 4 cb pulled, wings unlocked, and NWS button pressed.

ACTUATOR SINGLE ELECTRICAL FAILURE



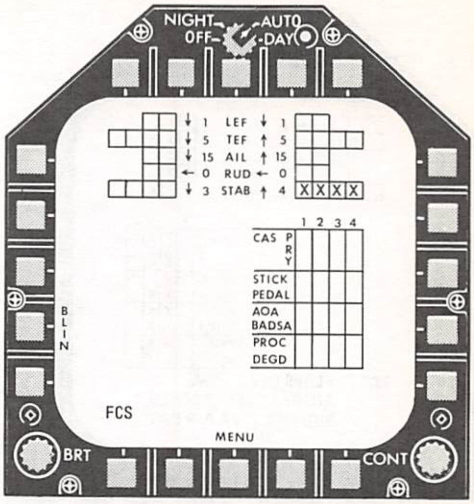
NOTE

FCS status display is shown for right stabilator channel 1 failure but is typical for any channel and left stabilator, leading edge flap, or trailing edge flap.

Effects:

No change in flying qualities. Two more electrical failures will cause actuator to revert to degraded mode.

ACTUATOR SINGLE SERVO VALVE FAILURE



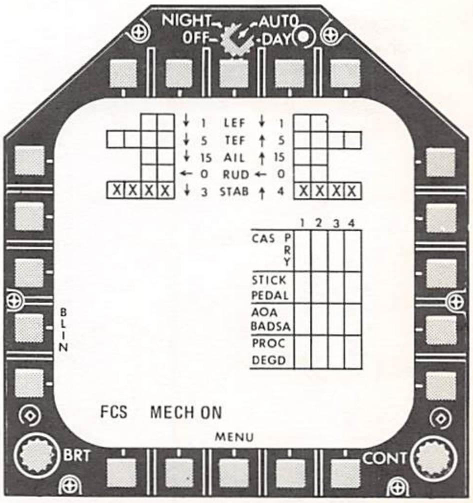
NOTE

FCS Status Display is shown for right stabilator servo valve 2 failure but is typical for either servo valve and left stabilator, either leading edge flap or either trailing edge flap.

Effects:

No change in flying qualities. One more servo valve failure or three electrical failures will cause actuator to revert to degraded mode.

STABILATOR ACTUATOR BOTH SERVO VALVES 4 CHANNEL FAILURE



Effects:

Stabilators in mechanical backup (MECH) mode.
Refer to MECH ON Caution procedure, this section.

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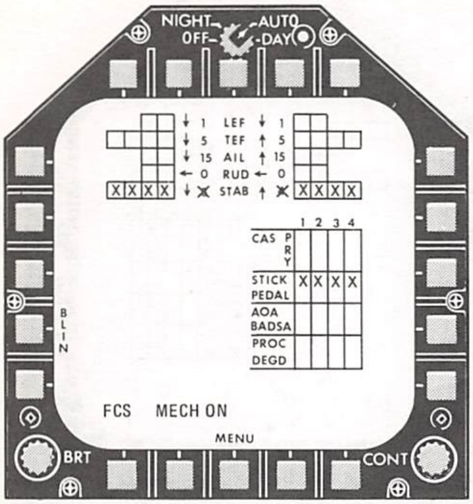
Figure 5-8A. FCS Failure Indications and Effects (Sheet 4)

PITCH STICK POSITION 4 CHANNEL FAILURE

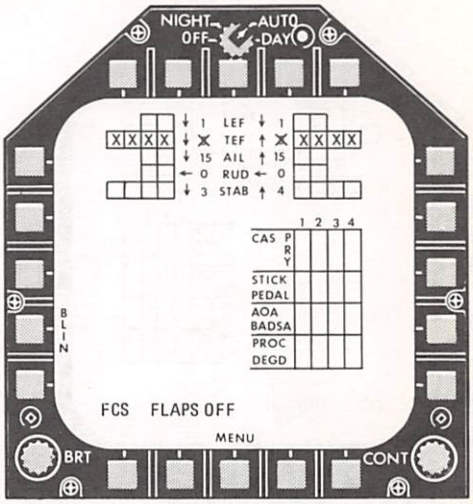


	1	2	3	4
CAS P				
R				
Y				
STICK	X	X	X	X
PEDAL				
AOA				
BADSA				
PROC				
DEGD				

Effects:

Stabilators in mechanical backup (MECH) mode
Refer to MECH ON Caution procedure, this section.

TRAILING EDGE FLAPS BOTH SERVO VALVES 4 CHANNEL FAILURE

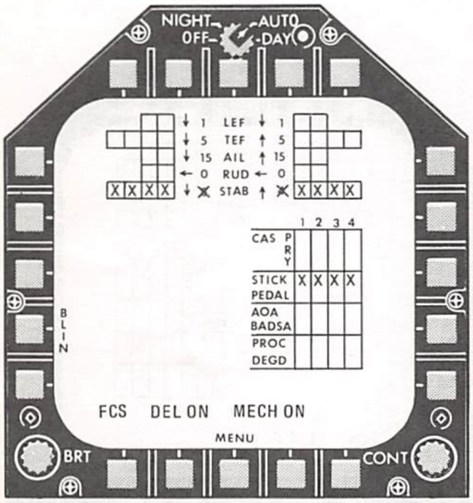


	1	2	3	4
CAS P				
R				
Y				
STICK				
PEDAL				
AOA				
BADSA				
PROC				
DEGD				

Effects:

Autopilot and ATC inoperative.
Trailing edge flaps hydraulically driven to 0°.
No aileron droop.

ROLL STICK POSITION 4 CHANNEL FAILURE



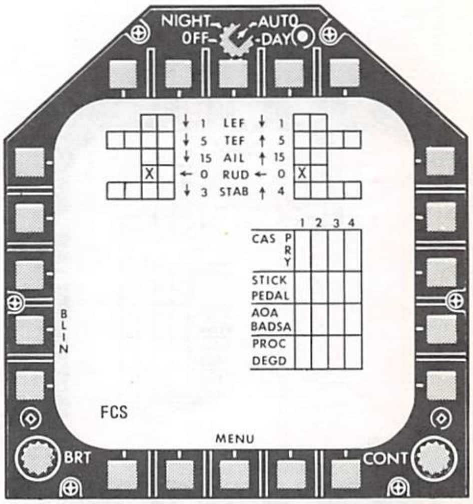
	1	2	3	4
CAS P				
R				
Y				
STICK	X	X	X	X
PEDAL				
AOA				
BADSA				
PROC				
DEGD				

Effects:

Stabilators in mechanical backup (MECH) mode
Refer to MECH ON Caution procedure, this section.

Flaps – AUTO
  Ailerons inoperative.
Flaps – HALF or FULL
  Ailerons droop but do not operate.

RUDDER CHANNELS 1 & 2 or 3 & 4 FAILURE



	1	2	3	4
CAS P				
R				
Y				
STICK				
PEDAL				
AOA				
BADSA				
PROC				
DEGD				

NOTE

FCS status display shows channels 1 and 2 failure example.

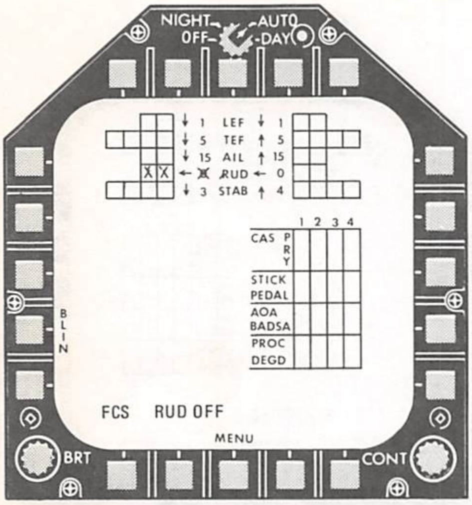
Effects:

No change in flying qualities.

18AC–NFM–00–(152–5)

Figure 5-8A. FCS Failure Indications and Effects (Sheet 5)

RUDDER CHANNELS 1 & 4 or 2 & 3 FAILURE



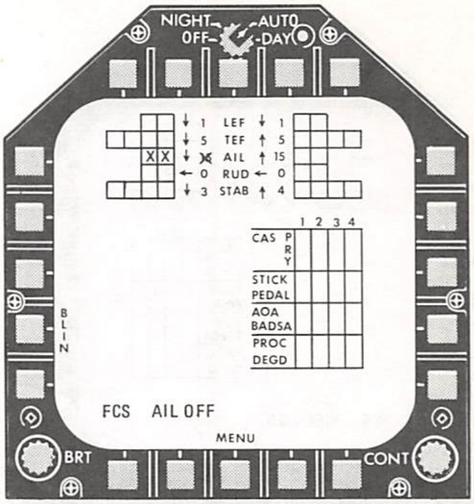
NOTE

FCS status display shows channels 1 and 4 failure example.

Effects:

Left rudder (channels 1 and 4) failed (flutter damped) or
Right rudder (channels 2 and 3) failed (flutter damped).
Directional control critical with one engine out
Autopilot inoperative
Flaps – HALF or FULL
No rudder toe–in.

AILERON CHANNELS 1 & 4 or 2 & 3 FAILURE



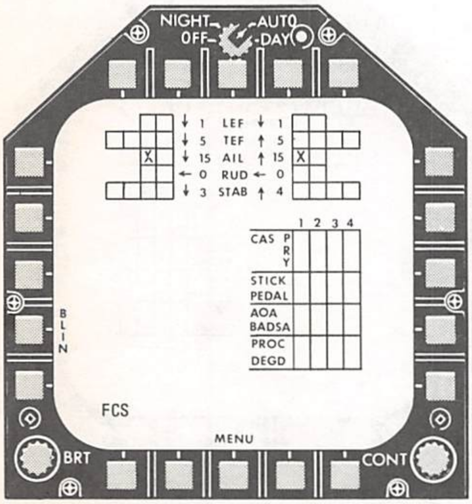
NOTE

FCS Status Display shows channels 1 and 4 failure example.

Effects:

Left aileron (channels 1 and 4) failed (flutter damped) or
Right aileron (channels 2 and 3) failed.
Autopilot inoperative.
Flaps – HALF
No aileron droop.
Trailing edge flaps 30°.
Leading edge flaps and rudders schedule normally.

AILERON CHANNELS 1 & 2 or 3 & 4 FAILURE



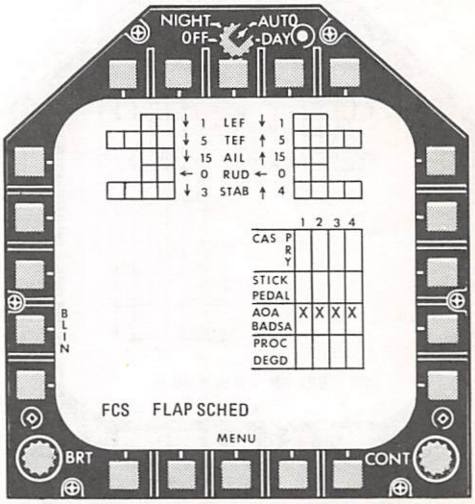
NOTE

FCS display shows channels 1 and 2 failure example.

Effects:

No change in flying qualities.

AOA 4 CHANNEL FAILURE



Effects:

Autopilot inoperative
Flaps – AUTO
Flaps schedule with airspeed only.
Flaps go to 3°/3° if ORIDE selected.
Flaps – HALF or FULL
Normal flying qualities.
Trailing edge flaps 30° or 45°.
Leading edge flaps and rudders schedule with air data (simulated AOA).

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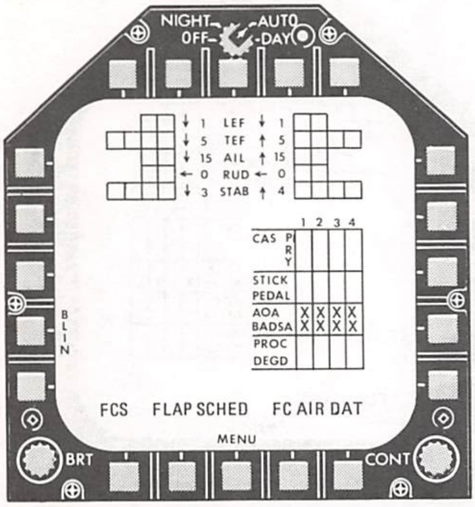
Figure 5-8A. FCS Failure Indications and Effects (Sheet 6)

AOA AND BACKUP AIR DATA SENSORS 4 CHANNEL FAILURE

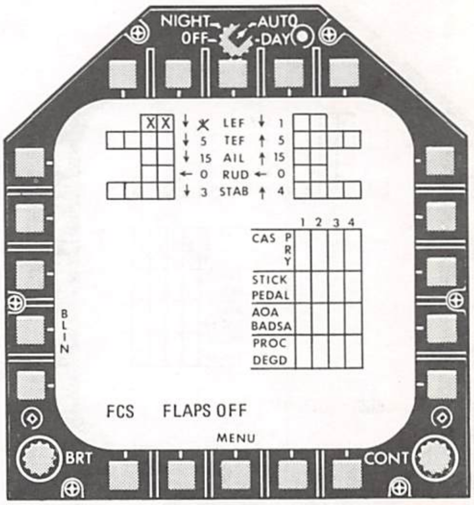


Effects:

Pitot–static instruments may be inaccurate.
Autopilot inoperative.
Flaps – AUTO
- Degraded flying qualities.
- Flaps freeze.
- Flaps go to 3°/3° if ORIDE selected.

Flaps – HALF or FULL
- No rudder toe–in.
- Flaps freeze.
- Flaps go to 17°/30° or 17°/45° if ORIDE selected.

LEADING EDGE FLAPS CHANNELS 1 & 4 or 2 & 3 FAILURE



NOTE

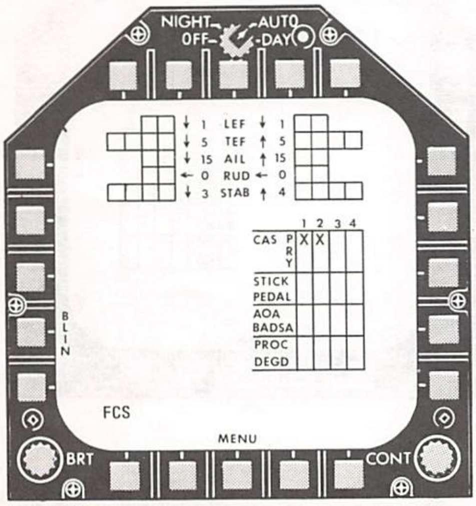
FCS status display shows channels 1 & 4 failure example.

Effects:

Failed leading edge flap frozen.
Autopilot inoperative.
Flaps – AUTO
- Good flap frozen symmetrically.
- Good flap operates differentially.

Flaps – HALF or FULL
- Good flap operates normally.

GYRO 2 CHANNEL FAILURE



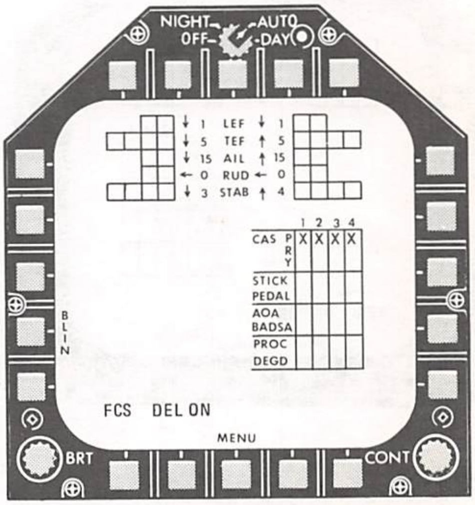
NOTE

FCS status display shows pitch rate gyro channels 1 and 2 failure for example.

Effects:

No change in flying qualities.
Autopilot inoperative.

PITCH RATE GYRO 4 CHANNEL FAILURE



Effects:

Pitch in direct electrical link (DEL) mode.
No pitch augmentation.
Autopilot and ATC inoperative.
Flaps – AUTO
- Poor pitch stability.
- Excessive speed brake transient.

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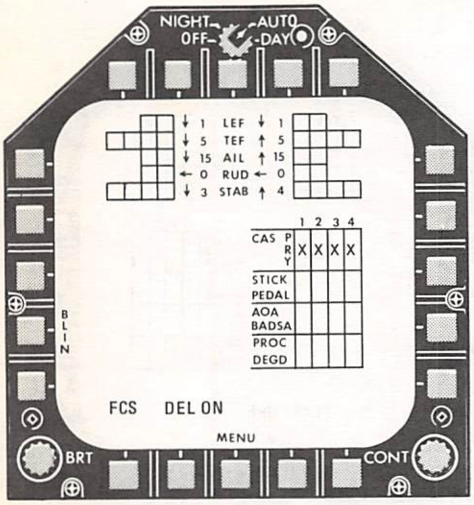
Figure 5-8A. FCS Failure Indications and Effects (Sheet 7)

ROLL RATE GYRO 4 CHANNEL FAILURE

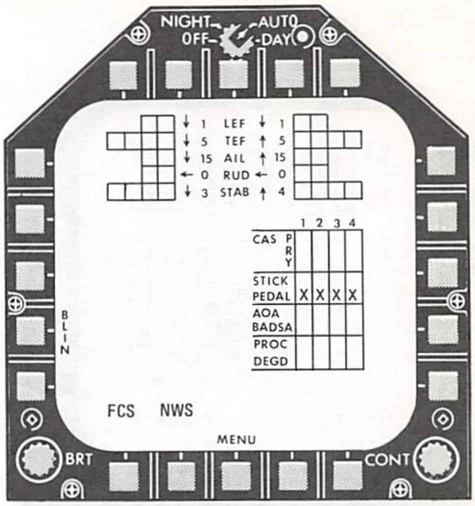


		1	2	3	4
CAS	P				
	R	X	X	X	X
	Y				
STICK					
PEDAL					
AOA					
BADSA					
PROC					
DEGD					

Effects:

Roll in direct electrical link (DEL) mode.
No roll augmentation.
Reduced roll damping.
Autopilot and ATC inoperative.

RUDDER PEDAL POSITION 4 CHANNEL FAILURE

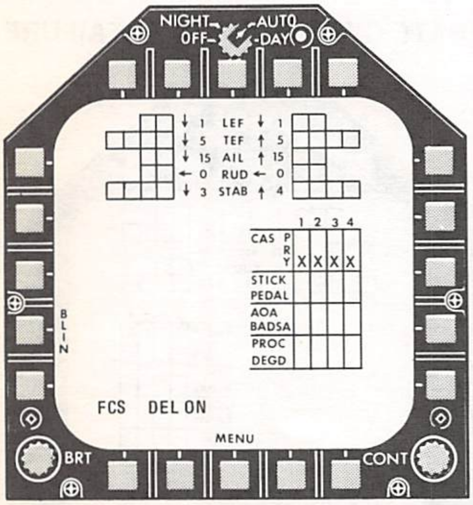


		1	2	3	4
CAS	P				
	R				
	Y				
STICK					
PEDAL		X	X	X	X
AOA					
BADSA					
PROC					
DEGD					

Effects:

No rudder pedal control of rudders.
No nosewheel steering.
Trim gives 15° rudder.
Lateral stick gives rudder for roll coordination.

YAW RATE GYRO 4 CHANNEL FAILURE

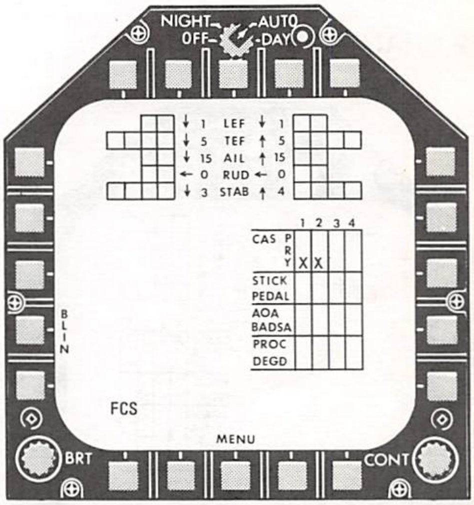


		1	2	3	4
CAS	P				
	R				
	Y	X	X	X	X
STICK					
PEDAL					
AOA					
BADSA					
PROC					
DEGD					

Effects:

Roll and yaw in direct electrical link (DEL) mode.
No roll and yaw augmentation.
Autopilot and ATC inoperative.
Flaps – AUTO
  Poor dutch roll damping.
  Poor turn coordination.
Flaps – HALF (do not use FULL flaps)
  Poor dutch roll damping.
  Poor turn coordination.

ACCELEROMETER 2 CHANNEL FAILURE



		1	2	3	4
CAS	P				
	R				
	Y	X	X		
STICK					
PEDAL					
AOA					
BADSA					
PROC					
DEGD					

NOTE

FCS status display shows lateral accelerometer channels 1 and 2 failure example.

Effects:

No change in flying qualities.
Autopilot inoperative.

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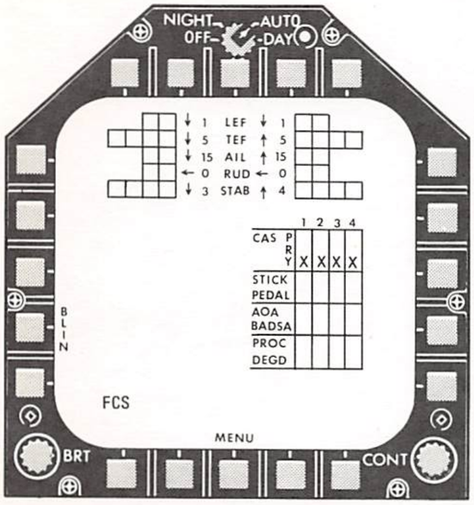
Figure 5-8A. FCS Failure Indications and Effects (Sheet 8)

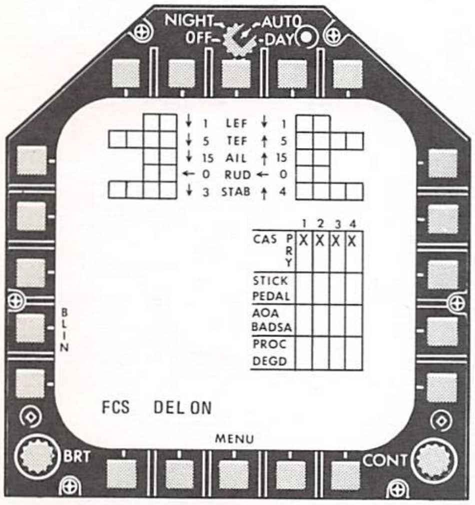
LATERAL ACCELEROMETER 4 CHANNEL FAILURE



Effects:

Degraded yaw CAS.
Poor turn coordination.
Autopilot inoperative.

NORMAL ACCELEROMETER 4 CHANNEL FAILURE



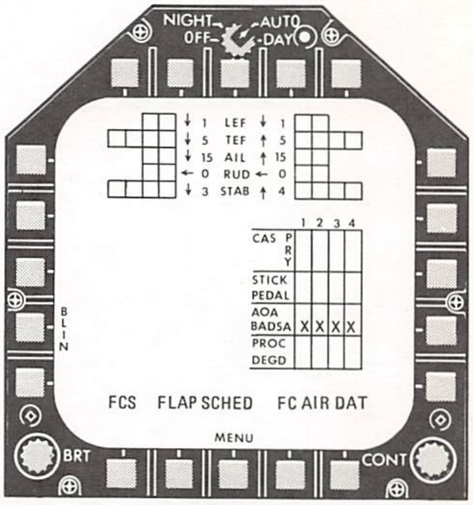
Effects:

- Pitch in direct electrical link (DEL) mode.
- No pitch augmentation.
- Autopilot inoperative.

Flaps – AUTO
- Poor pitch stability.
- Excessive speed brake transient.

Flaps – HALF or FULL
- Pitch in CAS mode.

BACKUP AIR DATA SENSORS 4 CHANNEL FAILURE



Effects:

- Pitot–static instruments may be inaccurate.
- Autopilot inoperative

Flaps – AUTO
- Degraded flying qualities.
- Flaps schedule with AOA only.
- Flaps go to 3°/3° if ORIDE selected.

Flaps – HALF or FULL
- Trailing edge flaps 30° or 45°.
- Leading edge flaps and rudders schedule with AOA.

PROCESSOR 4 CHANNEL FAILURE

NOTE

Processor 4 channel failure will cause many random FCS cautions.

Effects:

If software fault recovery process can clear fault –
- No Effect.

If complete processor 4 channel failure –
- No FCS failure indications on DDI.
- Stabilators revert to mechanical (MECH) mode.
- Ailerons and rudders revert to analog direct electrical link.
- Trailing edge flaps drive to 0°.
- Leading edge flaps lock in position at failure.

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Figure 5-8A. FCS Failure Indications and Effects (Sheet 9)

FCS FAILURE

The reliability of the FCS is very high and, when failures do occur, they usually occur singly. No single failure will affect flying qualities. The flight control system has multiple redundancy and is designed to fail to the least critical configuration. Two flight control computers each have two flight control channels. Within each channel, each axis (pitch, roll, or yaw) is separate so that failure of one axis does not affect the other two. If normal CAS functions fail, each computer also provides a digital direct electrical link (DEL) between stick inputs and flight control surfaces. If roll or yaw digital DEL fails, the computers provide an analog DEL to the ailerons and rudders. If pitch digital DEL fails, a direct mechanical link from the stick to the differential stabilator actuators provides limited pitch and roll control. Depending on which failures have occurred, flying qualities may be considerably degraded. Due to the variety of possible failure combinations, exact guidance cannot be given to cover every possible circumstance. However, specific procedures have been established for each FCS caution. Refer to the Warning/Caution/Advisory Displays, figure 5-1, for appropriate action. You must use your own judgement as to the flyability of the particular failure combination.

CAUTION

With 5.3.1 PROM, If FLAPS OFF or FX GAINS caution displayed, RESET may cause leading edge and/or trailing edge flaps to retract.

FX GAINS CAUTION (5.3.1 PROM)
FC AIR DAT CAUTION (AFTER 7.0 PROM)

Refer to Warning/Caution/Advisory Displays, figure 5-1. Fixed gains is commanded by the FCS computers if there is a discrepancy in the air data or AOA. After 7.0 PROM, fixed gains may be selected by the pilot. Reduce speed below 350 knots and AOA below 10° before selecting ORIDE on the gains switch. With the flap switch AUTO, except after 7.0 PROM, the gains are set to fixed values appropriate for low altitude-high speed flight. With the flap switch AUTO, after 7.0 PROM, the gains are set to fixed values appropriate for Mach 0.7 (235 knots) and 2° AOA at 35,000 feet. No noticeable transients occur entering or resetting from fixed gains. The stall margin is reduced. Longitudinal and lateral response is more sluggish as airspeed is reduced below the set value and is more sensitive as airspeed is increased above the set value. The airplane is easily controllable at normal cruising speed. Transition to or from the landing configuration at 200 knots at a safe altitude. Do not lower flaps in a turn as sideslip may occur due to the fixed gains logic. Avoid overcontrol and resulting PIO during flap transition. In the landing configuration the gains are set to values which permit landing with flaps HALF or FULL (133 knots and 8.1° AOA after 7.0 PROM). At higher airspeed, airplane response is sensitive but stable. At lower airspeed, airplane response is sluggish and takes longer to stabilize. Pitot-static instruments may be inaccurate.

DEL CAUTIONS (5.3.1 PROM)
DEL ON CAUTION (AFTER 7.0 PROM)

Refer to Warning/Caution/Advisory Displays, figure 5-1. Direct electrical link (DEL) operation is the lack of reliable feedback data or operation within the FCS. DEL operation will usually occur in only one axis but Y DEL operation forces the roll channel into R DEL. In the DEL mode, pilot inputs position the control surfaces as a direct function of pilot input. Damping of aircraft motion occurs only as a result of natural aircraft stability and is not enhanced by the FCS. Pilot inputs should be gentle. Allow short term airplane oscillations to dampen by themselves. Rapid pilot inputs may aggravate these motions. Use care during configuration changes such as speed brake, landing gear, and flap operation as the substantial aerodynamic changes will not receive damping from the FCS.

MECH ON CAUTION

Refer to Warning/Caution/Advisory Displays, figure 5-1. Mechanical operation (MECH ON) will occur if pitch digital DEL mode operation is not possible. This can be the result of various FCS failures, complete electrical failure (including the battery), or as a deliberate pilot selection (pulling FCC CHAN 1 and 2 circuit breakers) to conserve battery power for landing after a double generator or double transformer-rectifier failure. Flight in this configuration (mechanical stabilator; ailerons and rudders inoperative) has not been demonstrated. The airplane has been flown with mechanical stabilator control with ailerons and rudders operative. Switching transients into MECH ON are mild and feel initially like runway nose-up trim for most cruise conditions. Use care at low altitude above 0.8 Mach to avoid overcontrol in pitch and resulting PIO. Avoid large nose-down stick input during the transient. Allow the airplane to pitch up smoothly while reducing power and running in some nose-down trim to regain level flight at 250 to 300 knots. If the switch to MECH ON occurs in the takeoff or landing configuration, the nose will pitch down. Smoothly apply aft stick, add power to accelerate, raise the flaps to HALF and trim nose-up. Jettison wing stores and climb to a safe altitude. Plan to land with as much fuel as practical as flight characteristics are better with the more forward CG and increased static margin this provides.

1. Wing stores - JETTISON

FLAPS OFF CAUTION

Refer to Warning/Caution/Advisory Displays, figure 5-1. Leading edge flap (LEF) or trailing edge flap (TEF) failure is easily controllable, but stall margin may decrease and approach speed increase considerably. A LEF failure usually occurs when the LEF brakes lock the LEF's in response to an out-of-tolerance condition. If the LEF's are locked in a more up position than the automatic flap schedule dictates, then stall and departure AOA will be lower (as low as 10° AOA if the LEF's are at 0°). Buffet with the LEF's at 0° is moderate at about 7° AOA. Use care to prevent AOA excursions above 10°. With the LEF's locked at 20° to 30° down, landing configuration handling qualities are essentially normal. On airplanes with 5.3.1 PROM, a LEF failure will probably occur if more than 5G is pulled between Mach 0.7 to 1.0 below 10,000 feet. Press the FCS RESET button for more than ½ second to clear this failure.

With a TEF failure, if the TEF's are more up than the automatic flap schedule dictates, the airplane attitude will be more nose-up than normal at any given airspeed in AUTO. In the landing configuration, the approach speed will be much higher at on-speed AOA. An AOA of 10° to 11° may be used for landing, but the over-the-nose field of view will be reduced.

FLAP SCHED CAUTION (AFTER 7.0 PROM)

Refer to Warning/Caution/Advisory Displays, figure 5-1. The FLAP SCHED caution comes on when an AOA or air data failure prevents full maneuvering flap capability. The leading and trailing edge flaps may schedule with AOA but use frozen air data or vice versa. After 8.2 PROM, the FLAP SCHED caution also comes on if the leading edge flap cannot follow the flap command during high G flight. In this case, the caution should clear automatically when G is reduced. For all FLAP SCHED cautions, establish straight and level flight then check handling qualities. If the leading edge flaps are frozen in a more up position than the scheduled position, stall and departure will occur at a lower AOA than normal. If adverse handling qualities are noted, gain ORIDE may be selected below 350 knots and 10° AOA. With the gain switch in ORIDE above 350 knots, an uncontrollable divergent pitch PIO may occur. With the flap switch AUTO, ORIDE provides 3°/3° flaps.

Transition to the landing configuration at 200 knots, straight and level at a safe altitude, and check flying qualities. Airplane response may be sensitive near 200 knots but will probably be about normal at ON-SPEED AOA. If AOA is failed, leading edge flaps and rudder toe-in are scheduled by an AOA approximation for 1G flight. During turns and pull-ups, the leading edge flaps will not increase deflection so stall margin is reduced.

NWS CAUTION

Refer to Warning/Caution/Advisory Displays, figure 5-1. The NWS caution comes on when nosewheel steering is shut off due to detection of a failure in the system. After 8.2 PROM, emergency high gain nosewheel steering is available after an FCS channel 2 or 4 failure. To engage the emergency mode, pull the failed channel circuit breaker, unlock the wings, and press the NWS button. The NWS will remain engaged in the high gain mode after the NWS button is released. The emergency mode can be disengaged by pressing the paddle switch. The emergency mode should be engaged only for low speed taxi. Single channel operation prevents detection of NWS command failures so be alert for uncommanded steering. Press the paddle switch immediately upon detection of uncommanded steering.

Nosewheel steering is not available with a HYD 2 failure. The NWS caution will not come on but the NWS cue on the HUD will flash.

AILERON FAILURE
AIL OFF CAUTION (AFTER 7.0 PROM)

Refer to Warning/Caution/Advisory Displays, figure 5-1. When an aileron fails, it is driven to the faired position and is damped to prevent flutter. If the ailerons were drooped, the other aileron is driven to the undrooped position. Approach speed will be somewhat higher. The other aileron will continue to operate assisted by the differential stabilator for roll control. Roll damping will be noticeably less. Use care to prevent overcontrol and resulting lateral PIO, especially when approaching touchdown.

RUDDER FAILURE
RUD OFF CAUTION (AFTER 7.0 PROM)

Refer to Warning/Caution/Advisory Dislays, figure 5-1. When a rudder fails, it is driven to the faired position and damped to prevent flutter. The other rudder will continue to operate. Minimum single-engine control speed is increased.

JAMMED CONTROLS

With 5.3.1 PROM, stick inputs are force sensed and full command is available even if the stick is jammed. After 7.0 PROM, stick inputs are position sensed and a jammed stick will prevent normal control. If the linkage to the mechanical servo valve is jammed, an override spring cartridge allows stick motion. If the stick is jammed, trim provides ample authority for controlled flight. The autopilot, except for control stick steering, may also be used for airplane control.

OUT-OF-CONTROL RECOVERY

The airplane is out-of-control when it is not properly responding to pilot inputs. Normally, the first perceived motion in an out-of-control sequence is a combination of roll and yaw. Neutralizing the controls and retracting the speedbrake should recover the airplane from most situations. At near zero airspeeds, pitch control may be sluggish and the AOA slow to decrease regardless of yaw motion. However, if yawing/rolling persists, the airplane may be in a spin. Retard the throttles to IDLE early in the departure to prevent stall/flameout problems. If the motions are violent, grasp the left canopy bow handle to help stabilize your body before attempting recovery. Check AOA, airspeed and DDI's for command arrow.

With 5.3.1 PROM, if the DDI's have not switched to spin recovery mode (SRM) logic automatically, yaw rate must be confirmed visually or with the turn needle. If yaw rate is confirmed, release the stick and place the spin recovery switch to RCVY. With the yaw rate less than 50°/second, the spin recovery switch must be in RCVY, the flap switch must be in AUTO, and the airspeed must be below about 140 knots for the spin recovery system to activate. If the command arrow is present, ensure rudder and longitudinal stick are neutral and apply lateral stick in the direction of the command arrow.

After 7.0 PROM, the automatic spin recovery logic will switch the DDI's to the SRM logic and arm full anti-spin lateral controls. Apply stick in the direction of the command arrow. After 7.0 PROM, use of the manual spin recovery switch should not be required. If use of the switch is required for recovery, exercise caution during the pull-out since the flight controls will remain in SRM until the airspeed increases above about 250 knots or the switch is placed to NORM. This will result in very sensitive control in all axes until the flight controls return to CAS.

For all airplanes, the command arrow indicates the proper control stick position for upright or inverted spin. For upright spins, the command arrow commands lateral stick with the spin direction. For inverted spins, the command arrow commands lateral stick opposite the spin direction. Recovery will begin immediately, but may take up to one turn to become apparent. When the yaw rate stops, neutralize lateral stick and apply longitudinal stick as necessary to bring the nose below the horizon. For minimum altitude loss during recovery, advance throttles to MIL (MAX AB if altitude critical) and maintain 25° to 35° AOA and 230 to 240 knots. 35° AOA should only be used with a clean airplane. No more than 25° AOA should be used with an appreciable asymmetric load. When recovered check spin mode logic off and place the spin recovery switch to NORM. If still out-of-control with no indication of recovery below 10,000 feet AGL, eject.

OUT-OF-CONTROL RECOVERY (5.3.1 PROM)

*1. Controls - NEUTRAL/SPEEDBRAKE IN

If still out-of-control -

*2. Throttles - IDLE
*3. Yaw rate, AOA, airspeed, and DDI — CHECK

If spin confirmed (command arrow or sustained yaw) -

*4. Spin recovery switch - RCVY
*5. FCS - RESET

CAUTION

If a FX GAINS caution appears on the DDI, press FCS RESET for at least ½ second to permit activation of the spin recovery mode. The spin recovery system will not activate with the FCS in fixed gains.

*6. Lateral stick - WITH ARROW

If AOA hang-up or when yaw rate stops (no command arrow) -

*7. Lateral stick - NEUTRAL

*8. Longitudinal stick – FULL FWD IF AOA POSITIVE
– FULL AFT (IF AOA NEGATIVE)
*9. Throttles – MIL or MAX
*10. Above 150 knots – ROLL UPRIGHT AND RECOVER

If passing 10,000 feet AGL with no indication of recovery –

*11. Eject

OUT-OF-CONTROL RECOVERY (AFTER 7.0 PROM)

*1. Controls – NEUTRAL/SPEEDBRAKE – IN

If still out-of-control -

*2. Throttles – IDLE
*3. Yaw rate, AOA, airspeed, and DDI — CHECK

If spin confirmed (command arrow) –

*4. Lateral stick – WITH ARROW

If AOA hang-up or when yaw rate stops (no command arrow) –

*5. Lateral stick – NEUTRAL
*6. Longitudinal stick – FULL FORWARD (IF AOA POSITIVE)
– FULL AFT (IF AOA NEGATIVE)
*7. Throttles – MIL OR MAX
*8. Above 150 knots – ROLL UPRIGHT AND RECOVER

If passing 10,000 feet AGL with no indication of recovery –

*9. Eject

PART 4 – LANDING EMERGENCIES

FORCED LANDING

Landing on an unprepared surface or with both engines failed is not recommended. If an engine cannot be restarted or if a suitable landing site is not available, eject.

SINGLE – ENGINE LANDING

1. Reduce gross weight to minimum practical
2. All unessential electrical equipment – OFF
3. If failed engine core rotating freely, crossbleed to retain hydraulic system
4. Gear – DOWN (EMERG if HYD 2 inoperative)
5. Flaps – HALF
6. If right engine out, motor with APU
7. Fly on-speed AOA

If HYD 2 failed –

8. Make a Short Field Arrestment, if practical Aboard ship, the airplane must be towed out of the arresting gear.

LANDING GEAR UNSAFE/FAILS TO EXTEND

WARNING

With a planing link failure, do not cycle the landing gear. Make a fly-in arrestment with LSO assistance, if available.

IF ANY GEAR INDICATES DOWN AND LOCKED –

1. Do not cycle landing gear handle
2. Get visual inspection
3. Lights test switch – TEST, VERIFY 3 GREEN, GEAR HANDLE LIGHT OUT

If gear down light failed and gear handle light out –

4. Land, pin gear after landing rollout

If gear lights test good –

4. Slow below 180 knots
5. Landing gear handle – ROTATE 90° CLOCKWISE, PULL TO DETENT

NOTE

- After emergency extension of the landing gear, more brake pedal pressure is required to get braking equal to normal braking.

- After emergency extension of the landing gear with a good HYD-2A system, normal brakes may fail.

If brakes fail –

6. Emergency brake handle - PULL TO DETENT

If gear still indicates unsafe –

5. Refer to Landing Gear Emergencies - Landing chart-

IF ALL GEAR UP –

1. Landing gear circuit breaker - CYCLE
2. Landing gear handle - CYCLE
3. Slow below 180 knots
4. Landing gear handle - DOWN, ROTATE 90° CLOCKWISE, PULL TO DETENT
   If the landing gear handle will not move to the down position, pull the landing gear circuit breaker, then rotate the handle 90° clockwise and pull until the handle locks in the detent. The gear will extend by the emergency method with the gear handle up. The red light in the gear handle will remain on with the gear down and locked.

CAUTION

If the landing gear is lowered by the emergency method with the gear handle up, the gear handle may move enough to cause gear retraction without deliberate pilot action unless the landing gear circuit breaker is pulled.

NOTE

- After emergency extension of the landing gear, more brake pedal pressure is required to get braking equal to normal braking.

- After emergency extension of the landing gear with a good HYD-2A system, normal brakes may fail.

If brakes fail –

5. Emergency brake handle - PULL TO DETENT

If all gear still up –

5. Refer to Landing Gear Emergencies - Landing chart

LANDING WITH BLOWN TIRE

1. Anti-skid - OFF
2. Make a Short Field Arrestment.

LANDING WITH AFT CG

If the CG has moved aft of the aft CG limit, land as soon as practical. Delay in landing will cause the CG to move further aft as fuel is burned. If any fuel remains in the centerline fuel tank, consider inhibiting transfer which, with a full tank, will keep the CG approximately 2.5% further forward than with an empty tank. Maintain airspeed below 0.7 Mach and AOA less than 10° to minimize problems with longitudinal controllability and sensitivity. Jettison of external stores/tanks will normally not be required. However, if controllability problems are encountered, jettison external wing stores/tanks first followed by the centerline store/tank. Avoid the use of abrupt longitudinal control inputs. Use a smooth control technique when making attitude/angle of attack corrections. Precise control of the touchdown point may have to be sacrificed to avoid a longitudinal PIO.

If CG aft of aft CG limit –

1. Maintain airspeed below 0.7 Mach and AOA less than 10°
2. External stores - JETTISON (if required)

If stores cannot be jettisoned or CG still aft of 27.0% MAC –

3. Fly straight-in ON-SPEED approach
4. Minimize longitudinal stick motion which can result in a PIO.
5. Cushion the landing with thrust if necessary

FIELD ARRESTMENT

FIELD ARRESTING GEAR

Field arresting gear includes anchor chain, water squeezer, and Morest types. All require engagement of the arresting hook in a crossdeck pendant cable rigged across the runway. Location of the pendant further identifies the gear type as follows:

SHORT FIELD - Located 1500 to 2000 feet past approach end of runway. Usually requires request to rig.

MIDFIELD - Located near halfway point of runway. Usually requires request to rig for desired direction.

ABORT - Located 1500 to 2000 feet short of departure end of runway. Usually rigged for immediate use.

OVERRUN - Located shortly past departure end of runway. Usually rigged for immediate use.

A field may have all, none, or any combination of types. You must know the type, location, and compatibility with your airplane of the installed gear. You must know the local policy for rigging installed gear.

WARNING

Do not make an arrested landing with full or partly full aluminum external tanks. Jettison aluminum external tanks which contain fuel. Arrested landing with full or partially full filament wound external tanks is permitted.

CAUTION

An engagement in the wrong direction into chain gear will severely damage the airplane.

Determine the conditions of an emergency by all means available (instruments, other aircraft, LSO, RDO, tower or other ground personnel). If fuel is streaming, a field arrested landing is not recommended due to the high probability of sparks and heat from the hook igniting the streaming fuel. Determine the best available arresting gear and the type of arrestment. Notify control tower as far in advance as possible and give estimated time to landing in minutes. Unrigged gear will probably require 10 to 20 minutes to rig. If conditions allow, make practice passes to accurately locate arresting gear. Lock shoulder harness.

Engage arresting gear on the centerline, in three-point attitude, as slow as practical, and with feet off brakes. After arrestment, common sense and conditions determine whether to keep engines running or to shut down the engines and evacuate the aircraft.

SHORT FIELD ARRESTMENT

If there is a directional control problem, an anticipated stopping problem, or a minimum rollout is desired, make a short field arrestment. Request LSO assistance. The LSO should be near the touchdown point with a radio. Tell him of the desired touchdown point. Lower the hook before starting approach and get a positive hook down check. Determine maximum engagement speed at landing gross weight (see figure 5-10). Approach speed will depend on the emergency. A constant glide slope approach to touchdown is allowed (mirror or fresnel lens if available). Maintain approach power until arrestment is assured or waveoff is started. Touchdown on centerline at or just before arresting wire. Prepare for waveoff if wire is missed. After engagement, retard throttles to IDLE. Secure engines and evacuate aircraft if required.

LONG FIELD ARRESTMENT

Make a long field arrestment when there is a stopping problem (that is, aborted takeoff, wet or icy runway, loss of brakes, etc.) and it is not possible to go around and make a short field arrestment.If a long field arrestment is selected due to an emergency which causes an approach speed so fast that it will exceed the approach-end arresting gear limits, be prepared for main gear tire failure above 215 knots and nose gear tire failure above 190 knots. Lower the hook in time for it to fully extend before engagement (normally 1000 feet before arresting gear). Line up on runway centerline. Tell control tower of your intention to engage arresting gear so that aircraft landing behind you will be waved off. Do not delay a decision to go around based solely on the availability of long field gear.

FIELD ARRESTMENT GEAR DATA

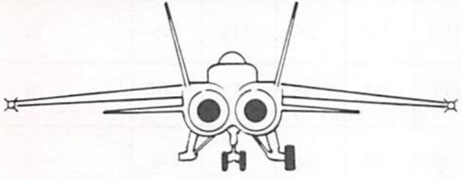
Maximum engaging speeds, gross weights, and off-center distances are shown in the Field Arrestment Gear Data chart, figure 5-10. The applicable Aircraft Recovery Bulletin contains more detailed information.

Landing Gear Emergencies - Landing

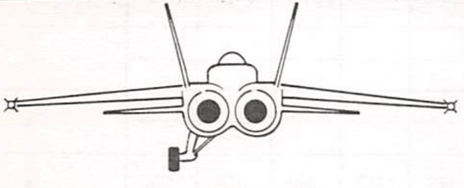
NOTES

- If all gear unlocked, retract gear and refer to all gear up.
- Any gear not locked down shall be treated as though it were up.
- With a planing link failure indication, do not cycle the landing gear. Make a fly-in arrestment with LSO assistance, if available.

ARRESTMENT NOT RECOMMENDED


ONE STUB MLG

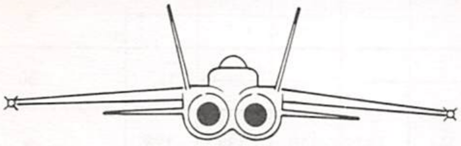
- Anti-skid-off
- Land on side of runway toward good gear
- Hold wings level as long as possible
- Use nosewheel steering and good brake to maintain track


NLG & ONE MLG UP

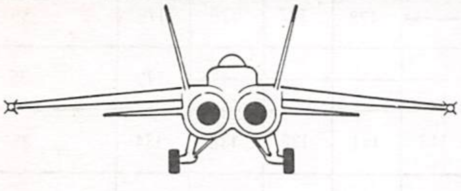
- Retract gear and refer to all gear up.

If unable to retract

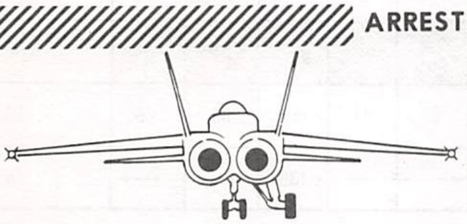
- Eject


ALL GEAR UP

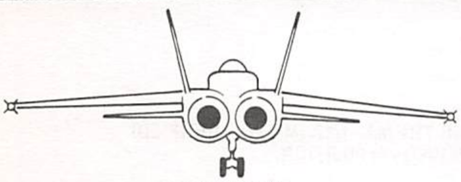
- Depressurize external tanks


NLG UP

ARRESTMENT RECOMMENDED


ONE MLG UP

- Make a fly-in arrestment with LSO assistance, if available


BOTH MLG UP

18AC-NFM-00-(44)D

Figure 5-9. Landing Gear Emergencies - Landing

Field Arrestment Gear Data

ARRESTING GEAR	AIRCRAFT GROSS WEIGHT/1000 pounds													MAXIMUM OFF – CENTER ENGAGEMENT FEET
	28	30	32	34	36	38	40	42	44	46	48	50	52	
	MAXIMUM ENGAGING SPEED (KNOTS)													
BAK–6	← 160 →				158	156	154	153	152	150	148	146	145	15
BAK–9	174	172	170	168	166	164	162	158	155	150	146	142	140	30
BAK–12/14 STD	← 180 →					177	175	170	165	160	156	152	148	50
BAK–12/14 1200′ R.O.	← 180 →												179	50
BAK–13	← 180 →													*
E–5 (HVY CHAIN)	← 150 →													*
E–5–1 (STD CHAIN)	← 163 →			159	155	153	150	147	145	142	140	138	136	*
E–5–1 (HVY CHAIN)	← 165 →													*
E–14–1	← 160 →												152	50
E–5 (STD CHAIN)	← 150 →							147	144	142	140	138	136	*
E–15 (200′ SPAN)	← 180 →									178	177	176	175	35
E–15 (300′ SPAN)	← 180 →												179	35
E–27	159	157	155	153	151	149	147	145	143	141	138	136	134	35
E–28	← 180 →							177	177	175	167	163	161	40
MA–1/1A (MA–1A Mod)	94	92	90	88	86	84	82	81	▨	▨	▨	▨	▨	*
M2	110	108	106	103	100	98	96	94	92	91	89	88	86	20
M–21	← 140 →								← 135 →					10

*Off center engagement may not exceed 25% of runway span

CAUTION

TO PREVENT DAMAGE TO THE LANDING GEAR WHEN UTILIZING THE MA–1/1A (MA–1A MODIFIED) ARRESTMENT GEAR, ENSURE WEBBING IS IN THE DOWN (INOPERATIVE) POSITION.

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Figure 5-10. Field Arrestment Gear Data

Ditching Chart

WARNING

THE AIRCRAFT SHOULD BE DITCHED ONLY WHEN ALL OTHER ATTEMPTS OF EGRESS HAVE FAILED.

DUTIES BEFORE IMPACT	POSITION	DUTIES AFTER IMPACT	EQUIPMENT	EXIT
1. Make radio distress call. 2. IFF–EMERGENCY 3. External stores–JETTISON. 4. Landing Gear–UP. 5. Wing Flaps–DOWN. 6. Arresting Hook–DOWN. 7. Visor–DOWN. 8. Oxygen mask or face visor–TIGHTEN or SEAL. 9. Canopy–JETTISON.	1. In Seat. 2. Feet on rudder pedals knees flexed.	1. Manual override handle–PRESS BUTTON AND ROTATE AFT AND UP. 2. Shoulder harness release fittings–RELEASE 3. Stand straight up without twisting to release survival kit sticker clips from the seat.	1. One man raft and Emergency equipment. 2. Life vest 3. Flash light.	Over canopy sill.
		NOTE The Emergency oxygen Bottle will actuate when the crewmember stands up. In the event of ditching and sinking in water when immediate escape is impossible, it is possible to survive under water with oxygen equipment or full pressure suit until escape can be made.		
NOTE In the event of a ditching following such situations as catapult shots or bolters, attempt to jettison the canopy prior to hitting the water.		4. Abandon aircraft.		
		WARNING Should aircraft be abandoned under water, exhale while ascending to the surface to prevent bursting of lungs due to pressure differential between lungs and outside of body.		
10. Lower seat, assume position for ditching. 11. Shoulder Harness–LOCK. 12. Fly parallel to swell pattern. 13. Attempt to touch down along wave crest. 14. When hook contacts water–SHUT DOWN ENGINES.		5. Inflate life vest. 6. Inflate life raft and secure Emergency equipment.		

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Figure 5-11. Ditching Chart

PART 5 - EJECTION

You must use the ejection seat to escape from the airplane in flight. See figure 5-12. If the canopy fails to jettison, the seat will eject through the canopy. Analysis of ejections shows:

a. Below 400 knots, only minor forces are exerted on the body and there is small risk of injury.
b. Between 400 and 600 knots, appreciable forces are exerted on the body making ejection more hazardous.
c. Above 600 knots, excessive forces are exerted on the body making ejection extremely hazardous.

When possible, slow the airplane before ejection to reduce the forces on your body.

Never actuate the manual override handle before ejection. When the handle is actuated, the pilot is released from the seat and the harness cannot be reconnected. This creates the following hazards:

a. In uncontrolled flight, you may be unable to assume the correct ejection position.
b. If an ejection is impossible, you will not be restrained during a forced landing.
c. After ejection, you will separate from the seat immediately and severe shock loads will be imposed on your body.

LOW ALTITUDE EJECTION

You must base your low altitude ejection decision on the minimum speed, minimum altitude and sink rate limitations of the ejection system. Figure 5-13 shows minimum ejection altitude for a given sink rate, and figures 5-14 and 5-15 show minimum ejection altitude for a given airspeed, dive angle and bank angle, such as encountered in a dive bombing run. Ejection seat trajectory is improved if you zoom the airplane. The additional altitude increases time available for seat separation and parachute deployment. Do not delay ejection if the aircraft is nose down and cannot be leveled. With wings level and no sink rate, ejection is feasible within the following parameters:

a. Ground level - zero airspeed
b. Ground to 70,000 feet - 600 knots maximum.
Above 400 knots, forces on the body make ejection hazardous.

HIGH ALTITUDE EJECTION

The basic low altitude procedure is applicable to high altitude ejection. The zoom is useful to slow the airplane to a safer ejection speed or to provide more time and glide distance if immediate ejection is not necessary. If the aircraft is descending out of control, eject above 10,000 feet AGL. Even if under control, do not delay ejection below 2000 feet. Head the aircraft toward an unpopulated area if possible.

SURVIVAL KIT DEPLOYMENT

During ground or low level ejection, you may not have time to deploy or remove the survival kit. If time permits, deploy the kit and inflate the life preserver during parachute descent. The following options are available:

a. Land with survival kit undeployed.
b. Deploy survival kit before ground impact or water entry. If water entry is anticipated, ensure that both lap belts remain attached until after water entry and that the upper half is snug against the body prior to contact.
c. Survival kit jettison

SURVIVAL KIT JETTISONING

If ground contact among trees, rugged terrain, high tension wires, etc. is anticipated, it may be desirable to remove the survival kit, hold it by a lap strap and drop it just before impact. To jettison or hand carry survival kit:

a. Open face visor and disconnect oxygen mask.
b. Release left lap strap release fitting.
c. Take hold of survival kit lifting handle with right hand.
d. Release right lap strap release fitting.

Ejection Procedures

IF TIME AND CONDITIONS PERMIT

- Tighten lap belt straps
- Lower helmet visor
- Stow loose equipment
- Assume proper ejection position (feet on rudders)
- If at low altitude zoom aircraft
- Eject at least 2000 feet (AGL)
- Slow airplane as much as possible

WARNING

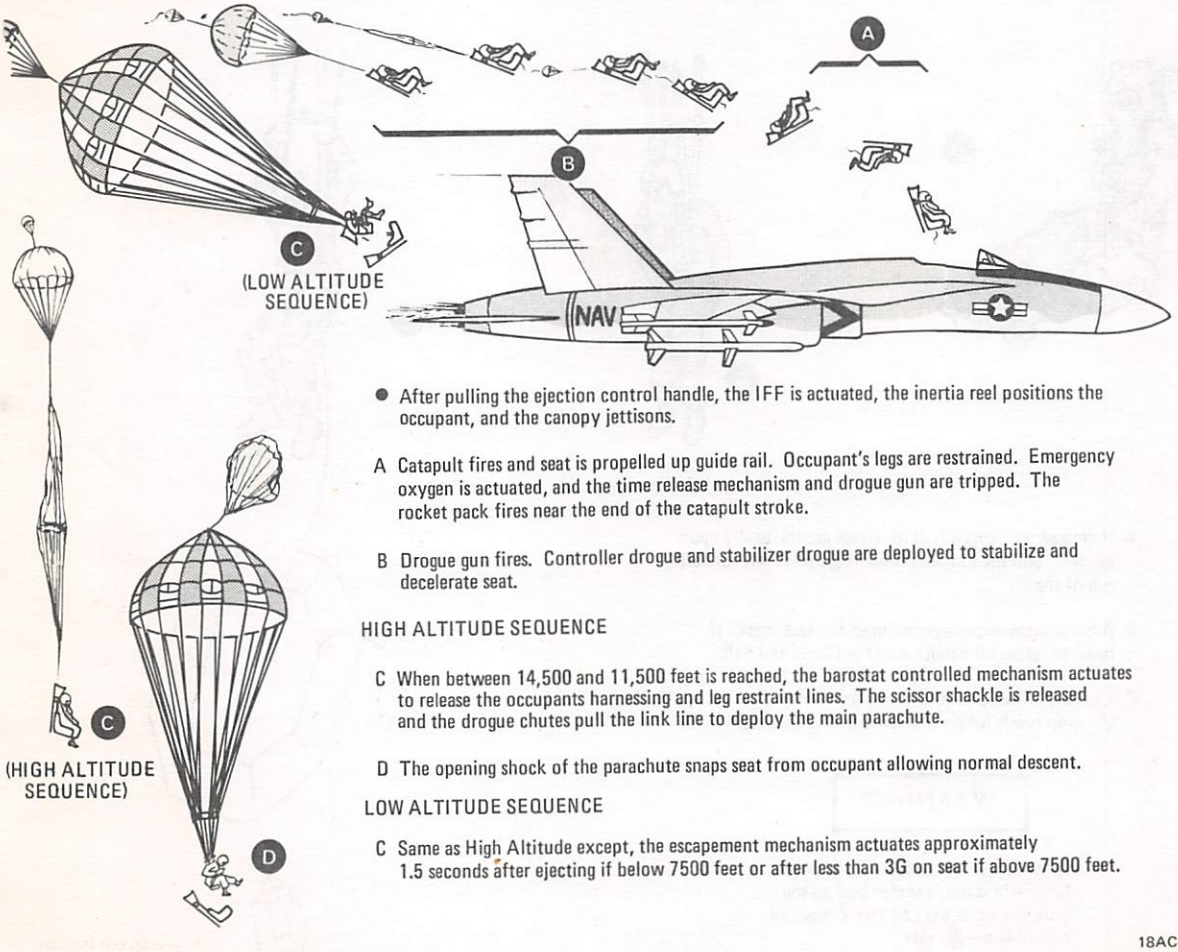
Minimum altitudes are dependent upon dive angle, airspeed, and bank angle. Recommended minimums are 10,000 feet (AGL) if out of control, and 2000 feet (AGL) in controlled flight.

1. Ejection control handle – PULL
   Grasp the ejection control handle, using a two–handed grip with thumb and at least two fingers of each hand. Pull up on handle and continue holding handle until pilot–seat separation.

NOTE

There are no provisions for manual bailout in the event of ejection seat failure.

AFTER EJECTION SEQUENCE



- After pulling the ejection control handle, the IFF is actuated, the inertia reel positions the occupant, and the canopy jettisons.

A Catapult fires and seat is propelled up guide rail. Occupant's legs are restrained. Emergency oxygen is actuated, and the time release mechanism and drogue gun are tripped. The rocket pack fires near the end of the catapult stroke.

B Drogue gun fires. Controller drogue and stabilizer drogue are deployed to stabilize and decelerate seat.

HIGH ALTITUDE SEQUENCE

C When between 14,500 and 11,500 feet is reached, the barostat controlled mechanism actuates to release the occupants harnessing and leg restraint lines. The scissor shackle is released and the drogue chutes pull the link line to deploy the main parachute.

D The opening shock of the parachute snaps seat from occupant allowing normal descent.

LOW ALTITUDE SEQUENCE

C Same as High Altitude except, the escapement mechanism actuates approximately 1.5 seconds after ejecting if below 7500 feet or after less than 3G on seat if above 7500 feet.

18AC–NFM–00–(53–1)C

Figure 5–12. Ejection Procedures (Sheet 1 of 2)

Ejection Procedures

MANUAL SEAT SEPARATION

IF BELOW 11,500 FEET AND AUTOMATIC PILOT SEAT SEPARATION FAILS TO OCCUR –

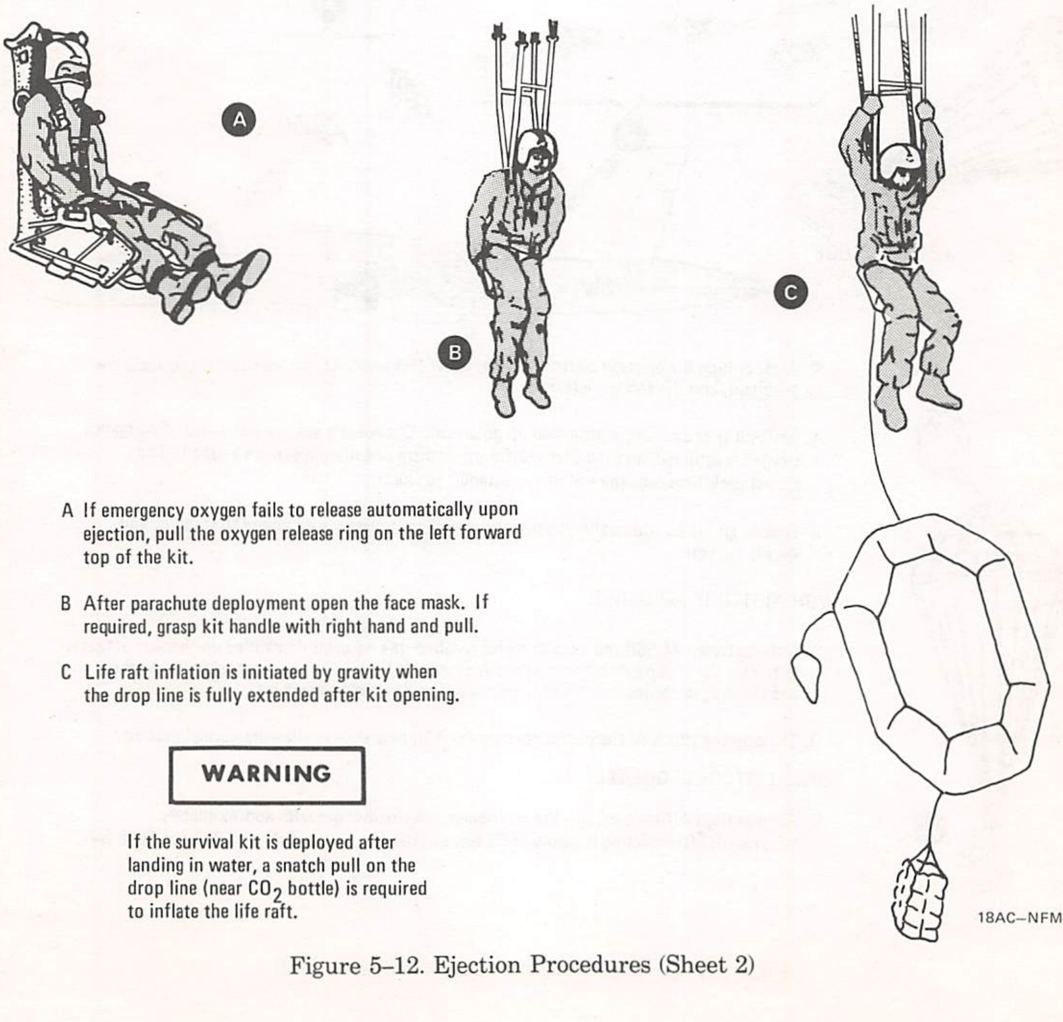
1. Manual override handle - PRESS RELEASE BUTTON AND ROTATE UP AND AFT

   To actuate manual override handle, depress handle release button and then rotate handle aft and up.

THE FOLLOWING OCCURS WHEN THE HANDLE IS ACTUATED:

- Manual override initiator cartridge fires to fire both the time release mechanism and drogue gun secondary cartridge.
- All occupant–to–seat restraints are released.
- Scissors shackle opens to release drogue chutes and deploy main parachute.

SURVIVAL KIT DEPLOYMENT



A If emergency oxygen fails to release automatically upon ejection, pull the oxygen release ring on the left forward top of the kit.

B After parachute deployment open the face mask. If required, grasp kit handle with right hand and pull.

C Life raft inflation is initiated by gravity when the drop line is fully extended after kit opening.

WARNING

If the survival kit is deployed after landing in water, a snatch pull on the drop line (near CO_2 bottle) is required to inflate the life raft.

Figure 5-12. Ejection Procedures (Sheet 2)

Ejection Sink Rate Effect

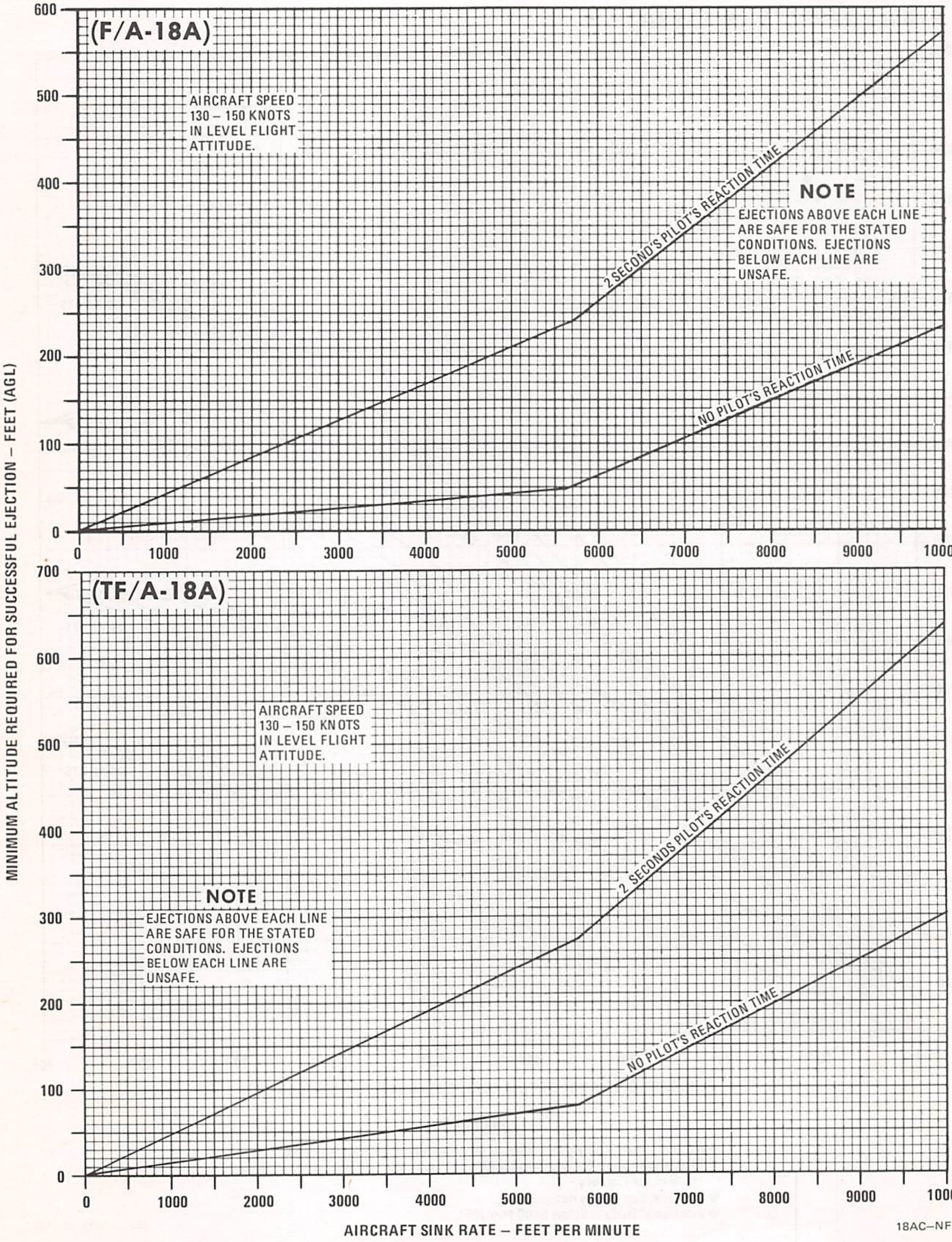
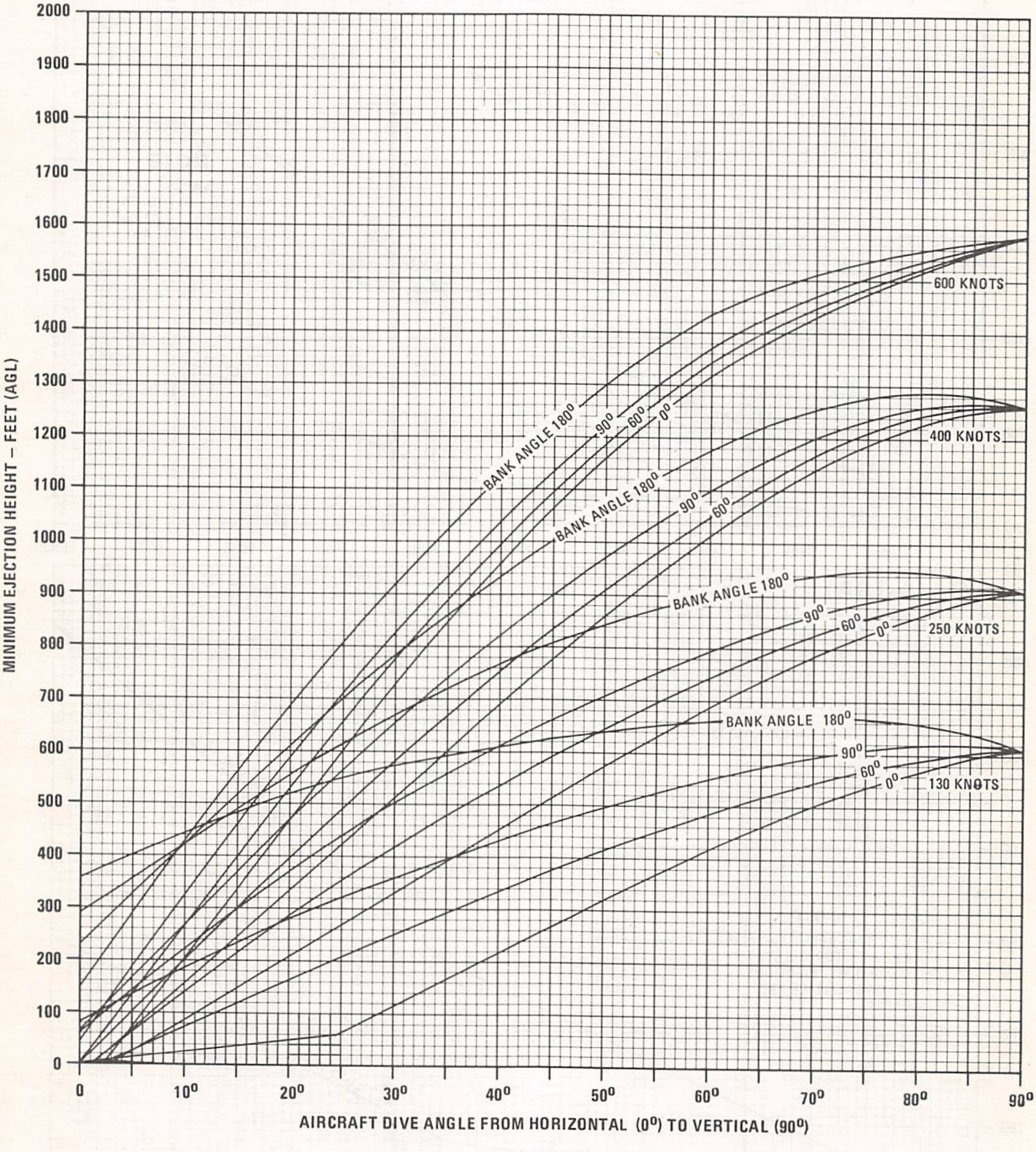


Figure 5–13. Ejection Sink Rate Effect

Minimum Ejection Altitude

AIRSPEED, DIVE ANGLE AND BANK ANGLE EFFECTS (F/A-18A)



NOTES

- Minimum ejection heights are based on initiation of the escape system.
- Bank angle data is for coordinated flight. Yaw or slip will increase the height required for recovery.
- Pilot reaction time is not included.
- Ejection altitude is below 5000 feet MSL.

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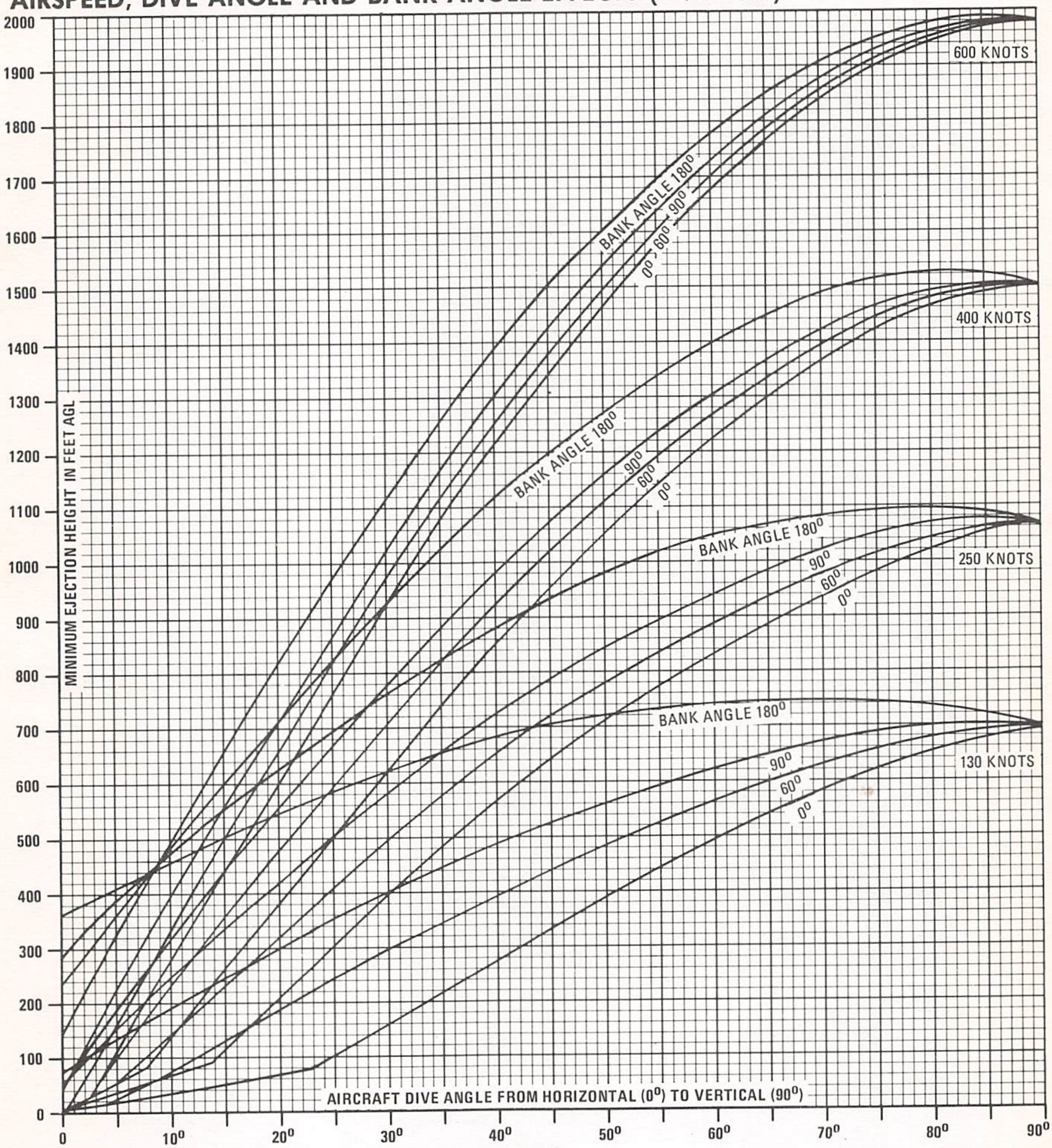
Figure 5-14. Minimum Ejection Altitude (F/A-18A)

Minimum Ejection Altitude

AIRSPEED, DIVE ANGLE AND BANK ANGLE EFFECTS (TF/A-18A)



NOTES

- Minimum ejection heights are based on initiation of the escape system, and the time required for a complete dual sequenced ejection is included.
- Bank angle data is for coordinated flight. Yaw or slip will increase the height required for recovery.
- Pilot reaction time is not included.
- Ejection altitude is below 5000 feet mean sea level.

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Figure 5-15. Minimum Ejection Altitude (TF/A-18A)

SECTION VI

ALL WEATHER OPERATION

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INSTRUMENT FLIGHT

BEFORE TAKEOFF

Thoroughly check flight instruments (primary and standby) and navigation equipment before takeoff. Cycle HUD attitude switch to STBY. (note standby attitude reference display) and back to AUTO.

If a climb through icing conditions is anticipated, place engine anti-ice and pitot switches ON.

INFLIGHT

Frequently crosscheck primary and standy instruments. If INS velocity vector is slowly flashing, select STBY attitude reference. If there is an abnormally high velocity change, monitor INS derived attitude carefully.

EXTREME WEATHER PROCEDURES

ICE AND RAIN

Avoid prolonged flight in known or suspected icing conditions to prevent engine FOD from ice ingestion. The engine will operate normally with minor ice ingestion.

If icing is anticipated or encountered –

1. Engine anti-ice switch – ON
2. Pitot anti-ice switch – ON
3. Climb or descend (if possible)

If icing can not be avoided –

4. Windshield anti-ice/rain switch – ANTI-ICE
5. Throttle – Stabilize above 75% RPM (avoid transients)

After clear of icing –

6. Throttle – maintain constant RPM as long as possible

Airframe/engine icing must be reported and engine inspected for FOD before next flight.

If landing in heavy rain –

1. Windshield anti-ice/rain switch – RAIN
   Do not operate rain removal on a dry windshield. Turn rain removal OFF immediately after landing or if WDSHLD HOT caution is displayed.
2. Reduce gross weight to minimum practical
3. ANTI-SKID switch – ON
4. Land ON-SPEED

If directional control problems occur after touchdown –

5. Make arrested landed if possible.

TURBULENT AIR AND THUNDERSTORM OPERATION

Avoid flight through thunderstorms. The radar MAP mode can be used to detect storm cells. If penetration must be made, fly at optimum cruise airspeed but not less than 250 knots if above 35,000 feet.

APPROACHES

Descent

Enroute descent should be flown at 250 knots, idle power.

Holding

Fly the holding pattern as directed/depicted and maintain 220 – 240 knots for maximum endurance at 15,000 – 20,000 feet. Total fuel flow will be approximately 3600 PPH (60 pounds/minute).

Non-Precision

The navigation aids available provide excellent position keeping capability, multiple redundancy and steering cues. INS offset data can be used to provide accurate steering to a tacan IAF and the course select option can be used to obtain a visual reference on the HI and steering cues on the HUD.

Penetration should be flown at 250 knots, 75% RPM and speedbrake as required. Dirty up at 10 NM from touch down. Plan for 800 pounds of fuel required to fly from the IAF to landing for a typical CV TACAN approach from 20,000 feet. Use of HALF flaps will reduce fuel flow and increase approach speed 7-9 knots.

Precision

The downwind leg should be flown at 230 - 250 knots with gear UP and flaps AUTO. Transition to the landing configuration when directed or no later than 6 NM from touch down. To begin descent, lower the velocity vector to approximately −3° and maintain ON-SPEED AOA. Small changes in velocity vector placement can be used to control glide path. Set radar altimeter at decision height and be prepared for missed approach.

DEGRADED SYSTEMS

If the INS built-in test detects a malfunction in the INS processor that prevents inertial navigation, the INS automatically reverts to the Attitude Heading Reference System (AHRS) mode which provides unfiltered attitude data to the mission computer. The AHRS mode can also be selected by placing the INS switch to GYRO.

WARNING

- When operating in AHRS mode at night or in IMC, avoid unnecessary high-G maneuvering flight. AHRS attitude should be frequently crosschecked with the standby attitude indicator, altimeter and magnetic compass.
- In the NAV mode, no indication of a slowly degrading INS is provided to the pilot other than increasing velocity errors. If there is an abnormally high velocity change, INS derived attitude should be carefully monitored.

If the INS fails, the standby attitude reference should be selected with the HUD attitude switch.

HOT WEATHER PROCEDURES

BEFORE TAKEOFF

During ground operations all non-essential electronic equipment (radar, tacan, IFF, etc) should be OFF until just prior to takeoff. Calculate the effect of temperature and altitude (density ratio) on takeoff and abort performance. On aircraft thru 161519 calculate minimum fuel for landing with the following formula: Add 90 pounds per °C (50 pounds per °F) above 21°C (70°F) to 1500 lb.

Low altitude flight with less than 4000 lb fuel remaining may cause the AMAD to overheat. Monitor fuel temperature inflight and, if temperature exceeds 75°C, land as soon as practical to prevent loss of AMAD(s) and generator(s).

When descending into warm humid conditions, abrupt canopy fogging can occur. To prevent this condition, move the defog handle to HIGH before descent.

Turn non-essential electrical equipment OFF before entering the landing pattern.

AFTER LANDING

Immediately turn avionics equipment OFF. Ground operating time can be extended by shutting down the left engine. Leave the canopy open during the day to ventilate the cockpit if blowing sand or dust is not a factor.

COLD WEATHER PROCEDURES

BEFORE TAKEOFF

During ground operation RPM will be lower than normal and hung starts should be anticipated. Maintain 70% RPM and turn pitot and engine anti-ice ON. If the airplane has not flown within 4 hours actuate the FCS exerciser mode (after 7.0 PROM) before attempting an FCS RESET.

ECS air flow volume may be low enough to cause an AVAIR HOT. Increase RPM to increase airflow.

TAKEOFF

Leave gear down for 1 minute after takeoff to clear snow or slush from the landing gear.

SECTION VII

COMM–NAV EQUIPMENT AND PROCEDURES

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COMMUNICATION – IDENTIFICATION EQUIPMENT

INTERCOM SYSTEM

Intercommunications between the pilot and ground crew is provided by the intercom system. The system also provides amplification and routing of both internally and externally produced tones. An external panel provides a receptacle and a volume control for the ground crew. The volume control adjusts the volume to the ground crew headset. The cockpit ICS volume control knob controls the intercom volume to the pilot's headset.

VHF/UHF COMMUNICATION SYSTEM

The VHF/UHF communication system provides air-to-air and air-to-ground communications, automatic direction finding (ADF), transmission of an internally generated 1020 Hz tone on any frequency selected, and monitoring of guard (emergency frequency). A relay mode allows normal or secure voice received by one VHF/UHF receiver-transmitter to be retransmitted by the other. The system consists of two receiver-transmitters (comm 1 and comm 2) with their associated controls and indicators. They provide transmission and reception of amplitude and frequency modulated signals (AM and FM) on 2990 frequencies spaced 100 KHz apart, or on 20 preset frequency channels within the frequency range of 30.0 to 400.0 MHz. They also continuously monitor a fixed tuned guard receiver (243.0 MHz). On airplanes 161702 and up, the system provides transmission and reception on 11,960 frequencies spaced 25 KHz apart. The comm 1 and comm 2 radios operate in the following frequency bands:

Frequency Band (MHz)	Modulation	Guard Channel (MHz)
30–87.9	FM	40.5
*108–155.9	AM	121.5
156–173.9	FM	156.8
225–399.9	AM	243.0

*Cannot transmit on 108 thru 117.975 MHz

The guard receiver in each radio monitors the guard channel for the frequency band in which the radio is operating. The frequency band is selected with the pushbutton keyboard by entering the desired frequency.

VHF/UHF CONTROLS AND INDICATORS

The comm 1 and comm 2 radios are operated by controls on the upfront control, the intercommunication panel, and the comm switch on the right (inboard) throttle grip.

UPFRONT CONTROL (UFC)

The upfront control (figure 7-7) is on the main instrument panel just below the head-up display (HUD). The controls include the comm 1 and comm 2 volume controls, the comm 1 and comm 2 channel selector knobs, the comm 1 and comm 2 channel display windows, the ADF function select switch, the scratch pad window, the option display windows, the option select pushbuttons, the pushbutton keyboard and the brightness control knob.

Comm 1 And Comm 2 Volume Controls

The two volume controls turn on and adjust the audio volume of their respective receiver–transmitters.

Comm 1 and Comm 2 Channel Selector Knobs

When the comm 1 channel selector knob is rotated, one of the following is selected for use by the comm 1 receiver–transmitter and displayed: One of 20 preset channels, a guard channel (G), or a manual frequency selection mode (M). When the comm 1 selector knob is placed to G (guard), the emergency guard frequency associated with the selected AM or FM frequency is selected for use but the option 1 select pushbutton must be pressed to enable the guard frequency. A colon appears in the option 1 display window. Pressing the option 1 select pushbutton again disables guard operation and the colon disappears. When the channel selector knob is pulled, the channel number and the frequency of the selected channel are displayed on the scratch pad window and if desired the frequency can be changed by using the keyboard pushbuttons. Also, the supplemental controls appear in the option windows (GRCV, SQCH, and CPHR). The comm 2 channel selector knob does the same thing as the comm 1 knob except that it controls the operation of the comm 2 receiver–transmitter.

Comm 1 And Comm 2 Channel Display Windows

These windows display the preset channel (1 thru 20), guard channel selection (G), or manual position (M) as selected by the comm 1 or comm 2 channel selector knobs.

ADF Function Select Switch

The ADF function select switch has positions labeled 1, 2, and OFF. Placing the switch to the 1 position turns on power to the ADF set and indicates ADF bearing to the station selected on the comm 1 receiver–transmitter. Placing the switch to the 2 position turns on power to the ADF set and indicates ADF bearing to the station selected on the comm 2 receiver–transmitter. With the switch set to OFF, power to the ADF is removed. The ADF bearing symbol, which is a small circle, is displayed on the HSI and indicates the ADF bearing to the station selected.

Scratch Pad Window

The scratch pad window displays the frequencies which are manually selected on the pushbutton keyboard, or it displays the frequency of the selected preset channel and the preset channel number when the channel selector knob is pulled to the extended position.

Option Display Windows

When the comm 1 or comm 2 channel selector knob is pulled, the following are displayed in the 5 option windows:

GRCV	When pressed, guard receiver enabled.
SQCH	When pressed, squelch reduces noise level in radio.
CPHR	When pressed, cipher mode operation enabled.
AM	When pressed, enables AM mode of operation in 225 to 399.975 MHz frequency band.
FM	When pressed, enables FM mode of operation in 225 to 399.975 MHz frequency band.

When any of these options are enabled, a colon appears in the left side of the corresponding option display window. If the comm 1 or comm 2 channel selector knob is pulled while the comm G XMT select switch is set to comm 1 or comm 2, the word GUARD is displayed vertically in the option display windows for approximately 10 seconds. If the option 1 select pushbutton is pressed, the emergency guard frequency of 243.0 MHz is enabled in whichever comm receiver–transmitter has been selected. A colon appears in the option display window.

Option Select Pushbuttons

Pressing the option select pushbuttons enable or disable the options for comm 1 or comm 2.

Pushbutton Keyboard

The keyboard enters the VHF/UHF frequency for comm 1 or comm 2 when the channel selector knob is turned to the manual (M) position. The keyboard is also used to enter a new frequency, if desired, for the preset channel number which is displayed on the comm 1 or comm 2 channel display window when the comm 1 or comm 2 channel selector knob is pulled to the extended position.

Brightness Control Knob

The knob has positions of BRT (bright) and DIM. The brightness of the display increases as the knob is rotated clockwise toward BRT.

INTERCOMMUNICATION PANEL

The intercommunication panel (figure 7–15) is on the left console. The switches which are used for VHF/UHF operation are the comm relay switch and the comm G XMT select switch.

Comm Relay Switch

This switch has positions of CIPHER, OFF, and PLAIN. Placing the switch to CIPHER enables the relay on COMM 1 transmitter of transmissions received on COMM 2 receiver, and vice versa in secure voice. With the switch in OFF the relay mode is disabled. Placing the switch to PLAIN enables the plain relay mode.

Comm G XMT Switch

This switch has positions of COMM 1, COMM 2, and OFF. Placing the switch to COMM 1 or COMM 2 tunes that receiver–transmitter so that it transmits and receives on the guard frequency of 243.0 MHz. In OFF, the receiver–transmitters resume normal operation.

ANTENNA SELECTOR SWITCH

The antenna selector switch is a three–position toggle switch with positions of COMM 1 UPPER, AUTO, and LOWER. Placing the switch to the COMM 1 UPPER or LOWER position selects the upper or lower antenna for the COMM 1 receiver–transmitter. With the switch in the AUTO position, the comm 1 receiver–transmitter automatically selects the antenna receiving a usable signal.

COMM SWITCH

A three–position comm switch is on the inboard throttle. The center position is the OFF position. Pushing the switch up enables comm 1 VHF/UHF receiver–transmitter to transmit; pushing the switch down enables the comm 2 receiver–transmitter to transmit.

SECURE SPEECH SYSTEM (KY–58)

The secure speech system is used for ciphering (coding) or deciphering (decoding) audio routed through the comm 1 and comm 2 receiver–transmitters. The system consists primarily of the KY–58 control panel assembly on the right console. Controls and indicators are on the control panel assembly and on the intercommunication panel on the left console.

KY–58 CONTROL PANEL ASSEMBLY

The control panel assembly functions as a ciphering or deciphering device for secure speech operation and it is also used for relaying ciphered information.

Ciphered Transmission

During ciphered transmissions, audio from the pilot's microphone is routed through the intercommunication panel to the control panel assembly where it is enciphered. The enciphered audio is then routed back to the intercommunication panel and then to comm 1 or comm 2 receiver–transmitter for transmission.

Ciphered Reception

During reception of ciphered information, the ciphered audio is routed from the comm 1 or comm 2 receiver–transmitter to the intercommunication panel and then to the control panel assembly for deciphering. The deciphered audio is routed back to the intercommunication panel and to the pilot's headset.

Ciphered Relay Mode

During ciphered relay mode of operation, ciphered information received on one UHF radio is routed from the radio, through the intercommunication panel and then to the second UHF radio for transmission. The ciphered information received on the first UHF radio is also routed through the intercommunication panel to the control panel assembly for deciphering and the deciphered audio is routed back through the intercommunication panel to the pilot's headset. This enables the pilot to hear deciphered relayed audio when in the ciphered relay mode.

CONTROLS AND INDICATORS

The control on the intercommunication panel is the comm relay switch. The controls on the control panel assembly (figure 7–1) are the mode select knob, the fill select knob, the volume control knob, and the power knob.

Comm Relay Switch

This switch has positions of CIPHER, OFF, and PLAIN. Placing the switch to CIPHER enables the cipher relay mode. With the switch in OFF the relay mode is disabled. Placing the switch to PLAIN enables the plain relay mode.

Mode Select Knob

The mode select knob has positions of P, C, LD, and RV. Placing the knob to P enables plain mode of operation. Placing the knob to C enables the cipher mode of operation. With the knob set to LD the load mode of operation is enabled. This mode is used for loading data into the KY–58 control panel assembly. Information pertaining to the RV knob position (receiver variable) will be supplied later.

Fill Select Knob

The fill select knob has positions of 1 thru 6, a Z 1–5 position, and a Z ALL position. Setting the knob to one of the six positions selects the position to be loaded with data. Placing the knob to Z 1–5 zeroizes data in positions 1 thru 5. Placing the knob to Z ALL zeroizes all data in positions 1 thru 6.

KY-58 Control Panel Assembly

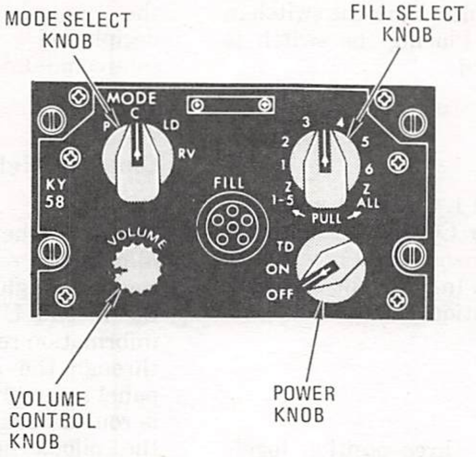

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Figure 7-1. KY-58 Control Panel Assembly

Volume Control Knob

The volume control knob adjusts the volume of the KY-58 control panel assembly audio.

Power Knob

This knob has positions of ON, OFF, and TD. Placing the knob to ON turns on power to the KY-58 control panel assembly. Placing the knob to OFF removes power to the system. With the knob in TD, power is turned on for the system and a time delay is selected for data processing.

IDENTIFICATION SYSTEM

The IFF (identification friend or foe) transponder set provides automatic identification of the airplane in which it is installed when challenged by a surface or airborne interrogator set and provides momentary identification of position (I/P) upon request. The system operates in modes 1, 2, and 3/A which are selective identification feature (SIF) modes and in mode C, the altitude reporting mode. Mode 4, which is a crypto mode, is available when the transponder computer (KIT) is installed in the aircraft.

IFF CONTROLS AND INDICATORS

The controls and indicators for IFF operation are on the upfront control, intercommunication panel, and the right or left digital display indicator (DDI).

UPFRONT CONTROL

The pushbuttons and indicators on this control used for IFF operation and display are the IFF function selector pushbutton, the ON/OFF selector pushbutton, the option select pushbuttons, the option display windows, the pushbutton keyboard, and the scratch pad window.

IFF Function Selector Pushbutton

Pressing this pushbutton enables IFF options to be displayed on the option display windows (on the right side of the upfront control); enables the IFF status windows (at the far left side of the scratch pad window) to display ON if the IFF is enabled; and allows the IFF code of the selected option to be displayed on the scratch pad window (located above the pushbutton keyboard). Mode 3 code is automatically displayed when the IFF function selector pushbutton is pressed.

On/Off Selector Pushbutton

Pressing this pushbutton turns the IFF system on or off after first pressing the IFF function selector pushbutton. When the IFF function selector pushbutton is pressed, the status of the IFF modes are displayed on the scratch pad window via the cues in front of the option display windows. The last mode 1 code selection appears in the option one display window and a 3 (for mode 3/A) and a four digit code for the last mode 3 code entry appears on the scratch pad window.

Option Select Pushbuttons

The option select pushbuttons are used to select the IFF mode desired. The pushbuttons, from the top pushbutton downward, select modes 1, 2, 3/A, 4, or C. Alternately pressing the option 1 pushbutton enables or disables mode 1 operation. When option 1 is enabled a colon appears to the left of the option 1 display window, and the scratch pad window displays mode 1 and the last entered code. A mode 1 code can be set in with the pushbutton keyboard by pressing the proper pushbuttons and then pressing ENT (enter). When option 2 is enabled, a colon appears to the left of the window and the scratch pad window displays mode 2. A mode 2 code cannot be set in with the pushbutton keyboard. Pressing the option 3 select pushbutton causes mode 3 and the last code entered to be displayed on the scratch pad window. When option 3 is enabled a colon appears to the left of the window. A mode 3 code can be set in with the pushbutton keyboard and then entered with the ENT pushbutton. On aircraft with the mode 4 computer installed, pressing the option 4 pushbutton enables or disables mode 4A or mode 4B. If the option display appears as a colon and a 4A, pressing the pushbutton again disables 4A and a 4B appears in the option 4 display window. Pressing the option pushbutton again enables mode 4B indicated by the colon that appears to the left of the 4B. A mode 4 caution is displayed on the DDI if the mode 4 codes are zeroized, if there is a fault in the mode 4 computer, or if the transponder is not replying to valid mode 4 interrogations (either due to mode 4 not being enabled or to a failure). When option 5 is enabled a colon appears to the left of the window. To enable the complete altitude encoding mode (C), both option 3 and option 5 (mode C) select pushbuttons must be enabled.

I/P PUSHBUTTON

Pressing the I/P pushbutton enables the IFF system to transmit momentary identification of position when interrogated.

INTERCOMMUNICATION PANEL

The intercommunication panel contains an IFF master switch, an IFF mode 4 switch, and an IFF crypto switch. The IFF mode 4 and IFF crypto switches are used for mode 4 on aircraft which have the mode 4 transponder computer (KIT) installed. With the IFF master switch in EMERG, the IFF R/T replies with the emergency code. With the switch at NORM, the IFF R/T replies to interrogations with selected codes.

Mode 4 Switch

This switch has positions of DIS/AUD, DIS, and OFF. Setting the switch to DIS/AUD enables an audio tone and the mode 4 advisory when the IFF is interrogated with valid mode 4 interrogations. With the switch in the DIS position, the mode 4 advisory is enabled when the IFF is responding to mode 4 interrogations. The switch in the OFF position disables the mode 4 advisory and the mode 4 audio tone.

Crypto Switch

This switch has positions of HOLD, NORM, and ZERO. Placing the switch to HOLD, with aircraft weight on wheels, retains the mode 4 codes if power to the system is lost. In the NORM position, mode 4 codes are available as long as power is not lost. Putting the switch to ZERO erases (zeroizes) the mode 4 codes.

IFF 4 CAUTION/VOICE ALERT

An IFF 4 caution is displayed on the left DDI whenever the mode 4 codes are zeroized, there is a fault in the KIT, or the transponder is not replying to valid mode 4 interrogations because of mode 4 not being enabled or because of a failure. At the same time that the caution condition occurs, a corresponding voice alert message is heard twice in the pilot's headset. The voice alert message is "mode 4 reply, mode 4 reply".

EMISSION CONTROL PUSHBUTTON

The emission control pushbutton on the right side of the upfront control is labeled EMCON. Pressing the pushbutton switches the IFF, if on, to a standby mode so that it cannot transmit. At the same time EMCON is displayed vertically on the option display windows. When emcon is turned off by pressing the pushbutton again, the IFF returns to its previous operating mode.

IFF BIT CHECK

To manually initiate an IFF BIT check, press the TCN/IFF pushbutton on the BIT display on the DDI. A BIT status display (BIT-IFF) appears if there is an IFF failure.

IFF ANTENNA SELECTOR SWITCH

The antenna selector switch is on the left console.

UPPER	Selects upper antenna.
AUTO	Provides automatic antenna selection.
LOWER	Selects lower antenna.

IFF EMERGENCY OPERATION

The IFF emergency mode automatically becomes active upon pilot ejection from the cockpit.

COMMUNICATION-NAVIGATION-IDENTIFICATION INTERFACE

The radios, ADF, tacan, ILS, data link, radar beacon, and IFF interface with the mission computer; and also interface with the CNI controls and upfront control displays through the communication system control. The communication system control (CSC) does the processing and data conversions necessary to communicate with and operate the equipment as commanded by the pilot through the upfront control or by the mission computer. The CSC also does the processing for the upfront control, including processing keyboard entries and providing the option readouts, cueing, and scratch pad display.

NAVIGATION EQUIPMENT

INERTIAL NAVIGATION SYSTEM (AN/ASN-130)

The inertial navigation system (INS) is a self-contained, fully automatic dead reckoning navigation system. The INS detects aircraft motion and provides acceleration, velocity, present position, pitch, roll, and true heading to related systems. Correction signals from accelerometers provide constant leveling. The INS uses both periodic and initiated built-in test (BIT). The periodic BIT monitors essential parameters within the system and provides inflight, shipboard, and ground failure detection and isolation. Initiated BIT is performed on the ground and accomplishes that portion of the failure detection and isolation capability which periodic BIT is unable to do. The INS system provides automatic INS degrading to an attitude heading reference system (AHRS) when INS BIT detects a significant fault in the inertial processor. An indication of automatic switching to AHRS is provided to the pilot on the HUD, but a caution is not provided. Operating in AHRS mode, the unfiltered INS attitude is displayed to the pilot. While a properly functioning AHRS provides a very stable attitude reference, it is more susceptible to precession during sustained maneuvering flight than the inertial mode.

WARNING

There are some subtle failure modes wherein INS attitude and/or velocity can degrade or fail and the INS will not provide an indication of the condition. Therefore, prior to and during flight conditions in which accurate attitude information is required, cross-checking of primary attitude indications versus standby attitude instruments should be performed. This cross-check should also include the true air speed ground speed relationship on the HI.

INERTIAL PLATFORM

The platform maintains continuous alignment in pitch, roll, and relative azimuth at all platform attitudes. The gimbals provide 360° freedom of rotation, allowing the platform to remain level with respect to local vertical and oriented to its alignment heading. After alignment the acceleration and attitude signals are used in the navigation computations. Signals representing pitch, roll, and azimuth are developed for aircraft attitude indications.

SIGNAL DATA CONVERTER

The signal data converter (SDC) contains the navigation computer, memory unit, inertial measurement unit (IMU), input/output, mux card, and analog/digital card. The IMU contains the platform and platform control cards. During carrier align, the SDC automatically initializes at system turn on to SINS (ship inertial navigation system) Z-lever arm data (vertical distance between SINS and carrier deck) or the Z-lever arm data can be manually changed for hangar deck operations. The SDC input/output unit provides all communication between the INS and other avionics systems.

NAVIGATION COMPUTER

The navigation computer provides for inertial alignment and navigation computations. The navigation computer and associated electronics process the acceleration and attitude signals for computing east/west, north/south, and vertical velocities and true heading. Also the calculations for inertial attitude and aircraft present position (latitude and longitude) are computed.

INS CONTROLS AND INDICATORS

The controls and indicators for the inertical navigation system (figure 7-2) are divided into three types: power and mode, alignment, and navigation. A description of these three types follow:

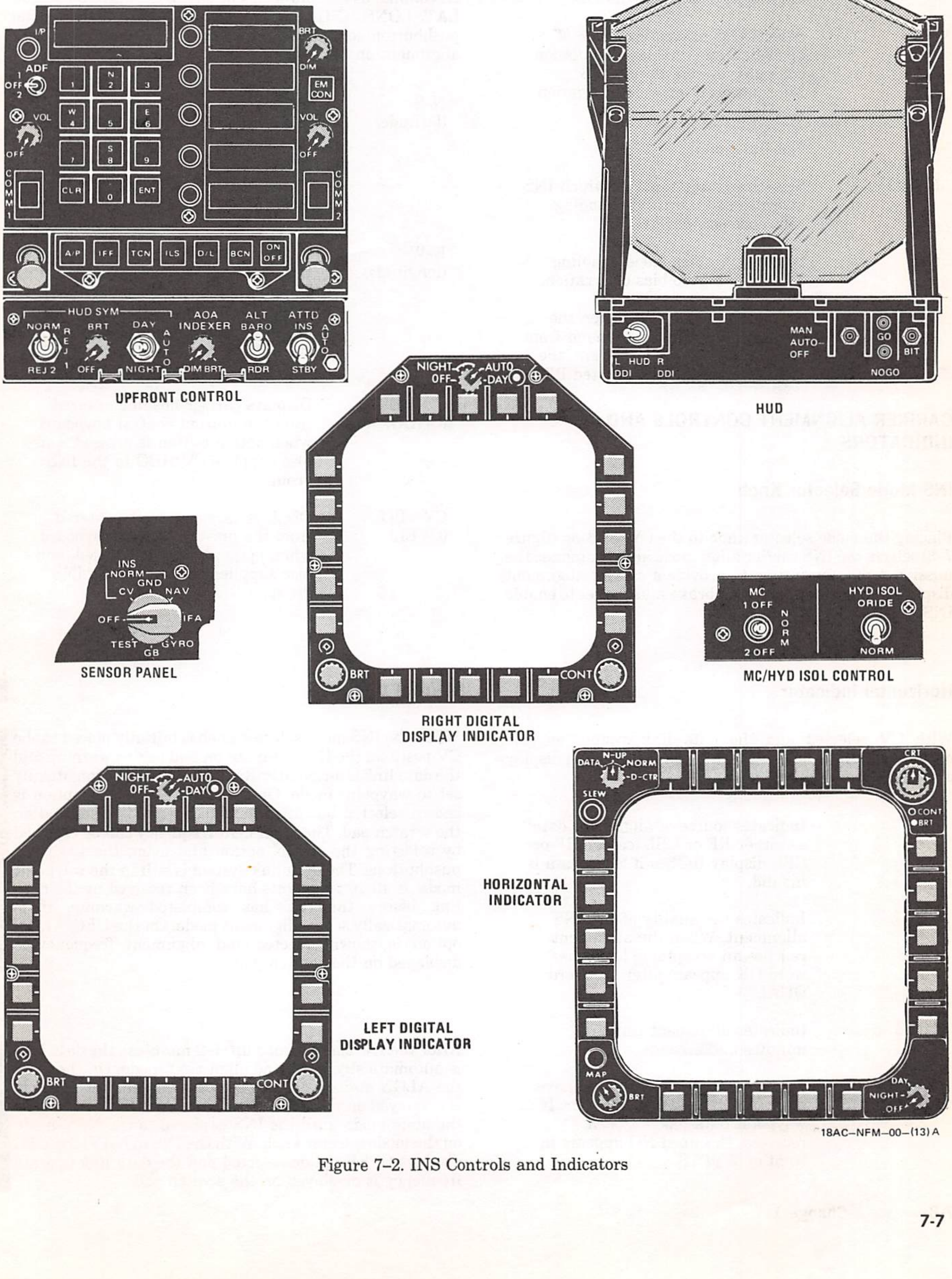
POWER AND MODE CONTROLS AND INDICATORS

INS Control Panel

The INS control panel on the right console, contains a mode selector knob which selects various modes of INS operation.

OFF	Power is removed from the INS.
CV	Selects INS carrier align mode and commands the mission computer system to provide a carrier alignment display on the HI.

INS Controls and Indicators



UPFRONT CONTROL

HUD

SENSOR PANEL

RIGHT DIGITAL DISPLAY INDICATOR

MC/HYD ISOL CONTROL

HORIZONTAL INDICATOR

LEFT DIGITAL DISPLAY INDICATOR

Figure 7-2. INS Controls and Indicators

GND	Selects INS ground align mode and commands the mission computer system to provide a ground alignment display on the HI.
NAV	Selects INS navigation mode of operation and enables the mission computer system to use INS information to provide navigation steering.
IFA	Not functional.
GYRO	Selects attitude mode in which INS operates as an attitude heading reference set (AHRS).
GB	Selects gyro bias mode enabling INS to do a gyro bias calibration.
TEST	Selects the test mode. When the INS is enabled by a command from the mission computer system, the INS can perform an initiated BIT.

CARRIER ALIGNMENT CONTROLS AND INDICATORS

INS Mode Selector Knob

Placing the mode selector knob to the CV position (figure 7-3) selects the INS carrier align mode and commands the mission computer system to provide a carrier alignment display on the HI. The parking brake must be set to enable INS alignment.

Horizontal Indicator

With CV selected and the data link system on and operational, the following RF or cable carrier align display also appears on the HI:

CV	Indicates source of alignment data as either RF or CBL (cable). RF or CBL display flashes if SINS data is invalid.
QUAL	Indicates the quality of the INS alignment. When the alignment reaches an acceptable level the word OK appears after the word QUAL.
TIME	Indicates alignment time in minutes and seconds.
WYPTS	Indicates whether waypoints have been received from the carrier. If waypoint data has not been received, the word NO appears in front of WYPTS.

Normally, the INS is carrier aligned using the data link; but if the data link signal is not available, the backup manual system is used. With the INS mode selector knob set to CV, pressing the MAN (manual) pushbutton on the HI commands the following options on the upfront control: LAT, LONG, CHDG, and CVEL. At the same time the pushbutton commands the display for a manual carrier alignment on the HI as follows:

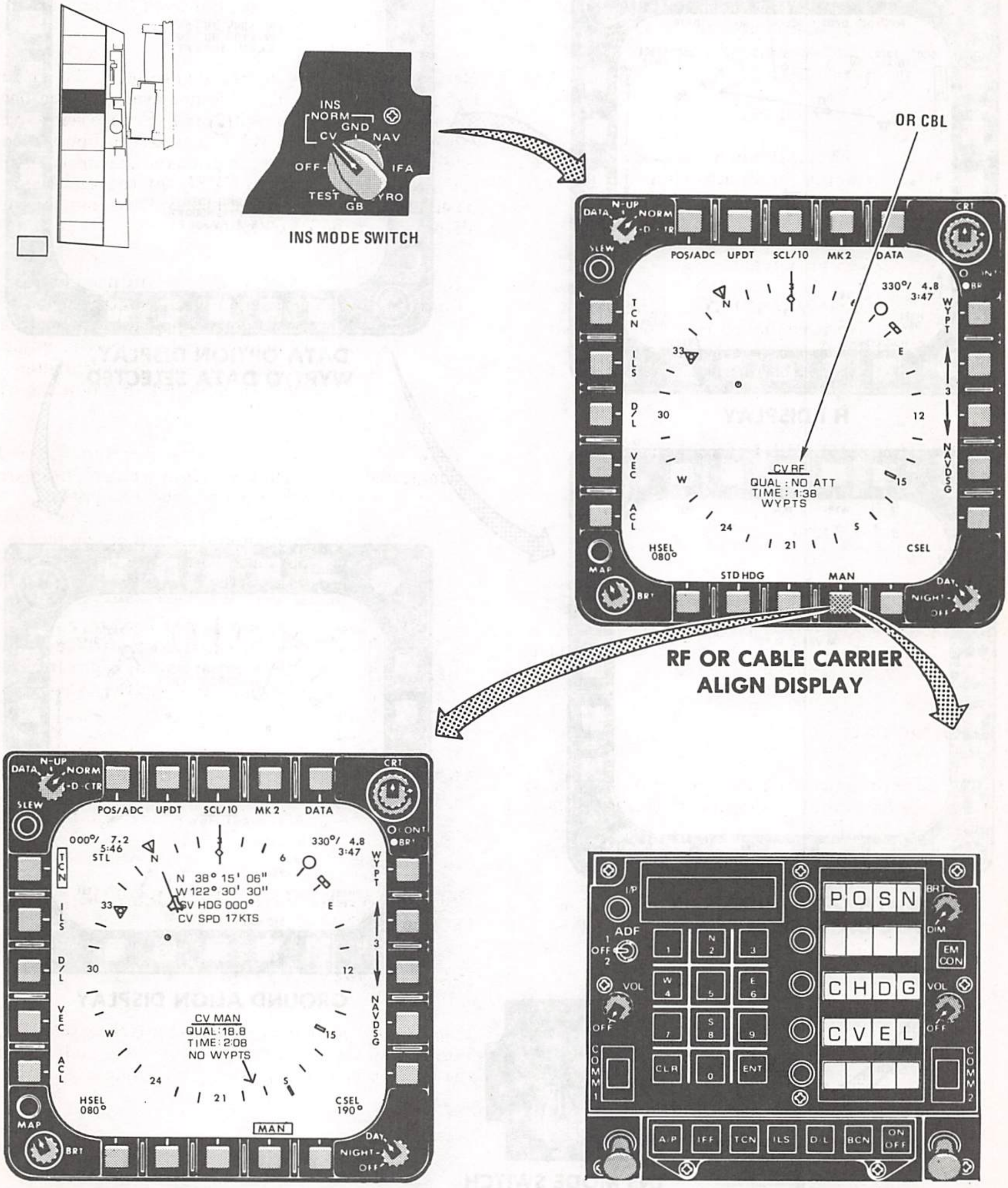
N-S (latitude)	Displays carrier latitude entered from the upfront control keyboard. Latitude is supplied to the mission computer system when the option button is pressed. The computer supplies data to INS group and to the HI.
E-W (longitude)	Displays carrier longitude entered from the upfront control keyboard, when option button is pressed, longitude is supplied to the mission computer system. The computer supplies data to the INS group and to the HI.
CV HDG (CHDG)	Displays carrier heading entered from the upfront control keyboard when option button is pressed, and also supplies CV HDG to the INS group.
CV SPD (CVEL)	Displays carrier velocity entered from the upfront control keyboard when option button is pressed, and also supplies CV SPD to the INS group.

Upfront Control

When the INS mode selector knob is initially placed to the CV position, the INS is turned on and begins warmup and the data link is automatically turned on and automatically set to waypoint mode. On the UFC, the WYPT option is shown selected but alignment frequency is displayed on the scratch pad. The alignment frequency can be changed by selecting the ALGN option and using the keyboard pushbuttons. The data link system is still in the waypoint mode. If all 10 waypoints have been received by the data link before the INS has completed warmup, it is automatically set to alignment mode. On the UFC, ALGN option is shown selected and alignment frequency is displayed on the scratch pad.

After the INS has warmed up (1-2 minutes), the data link is automatically set to the alignment mode. On the UFC the ALGN option is shown selected and alignment mode is displayed on the scratch pad. The data link remains in the align mode until the INS is placed to the NAV mode on the mode selector knob. With the INS in NAV, the UFC displays OPER option selected and the data link operate frequency is displayed on the scratch pad.

INS Carrier Align



MANUAL CARRIER ALIGN DISPLAY

MANUAL CARRIER ALIGN OPTIONS

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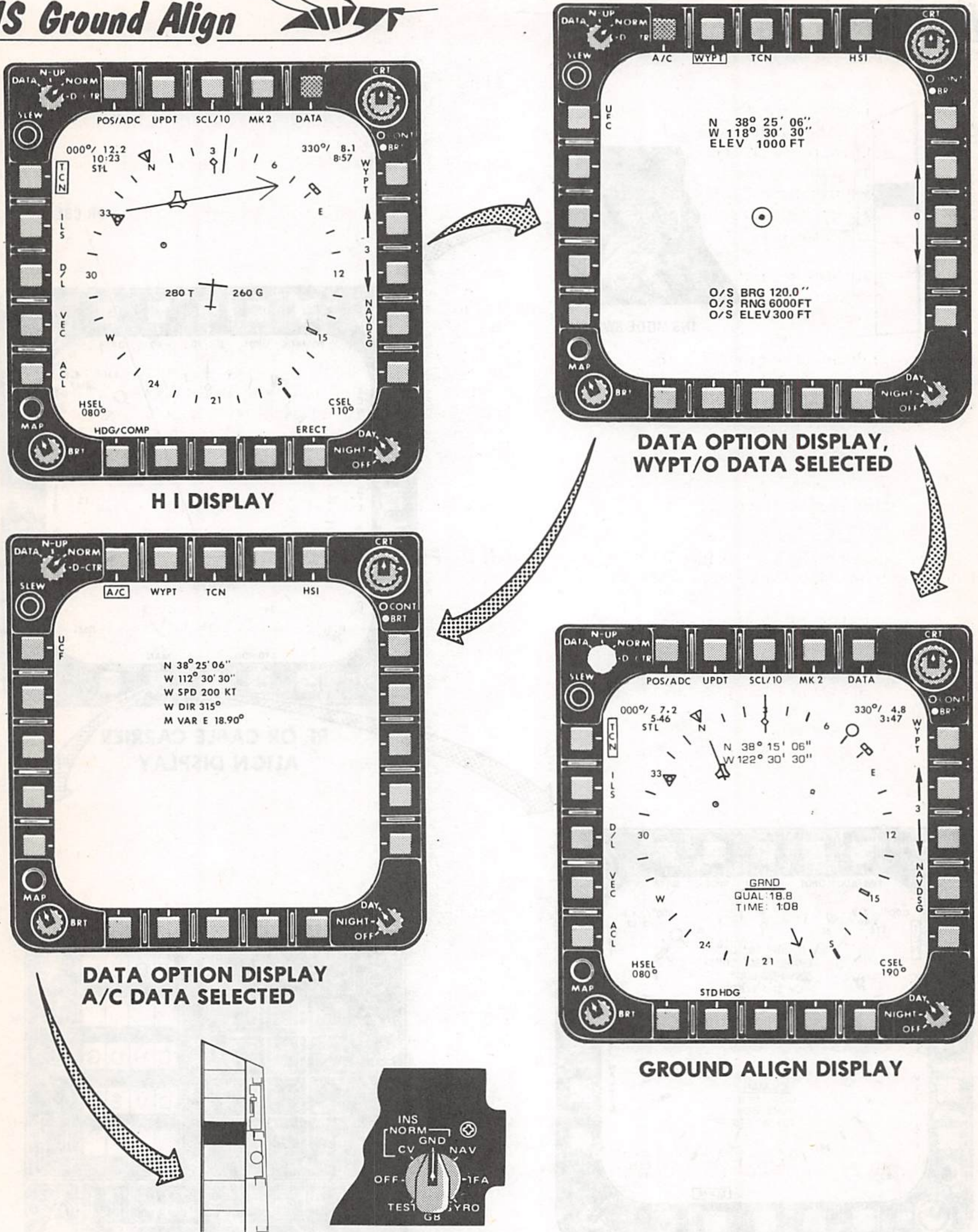
Figure 7-3. INS Carrier Align

INS Ground Align



H I DISPLAY

DATA OPTION DISPLAY, WYPT/O DATA SELECTED

DATA OPTION DISPLAY A/C DATA SELECTED

GROUND ALIGN DISPLAY

INS MODE SWITCH

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Figure 7–4. INS Ground Align

GROUND ALIGNMENT CONTROLS AND INDICATORS

INS Mode Selector Knob

Placing the mode selector knob to the GND position (figure 7-4) selects the ground alignment mode and commands the mission computer system to provide a ground align display on the HI. The parking brake must be set to enable INS alignment. WYPT 0 is the INS reference for alignment.

Horizontal Indicator

N–S (latitude)	Displays aircraft position latitude last entered from the upfront control for waypoint 0.
E–W (longitude)	Displays aircraft position longitude last entered from the upfront control for waypoint 0.
GRND	Indicates ground alignment mode has been selected on INS mode selector knob.
QUAL	Indicates the quality of the INS alignment. When alignment reaches an acceptable level, the word OK appears after the word QUAL.
TIME	Indicates alignment time in minutes and seconds.

DATA pushbuttonWhen pressed it provides WYPT (waypoint) data display on the HI.

Pressing the A/C pushbutton provides aircraft data display on the HI.

N–S (latitude)	Displays aircraft position latitude.
E–W (longitude)	Displays aircraft position longitude.
WSPD	Displays wind speed.
WDIR	Displays wind from direction.
MVAR	Displays magnetic variation.
UFC pushbutton	When pressed it enables A/C data options to be entered via the upfront control.
HSI pushbutton	When pressed it returns the display presentation to HSI display.

Upfront Control

Pressing the UFC pushbutton on the HI enables the data options for A/C or WYPT to be displayed on the upfront control.

STORED HEADING MODE

Stored heading mode is provided to reduce alignment time. If an INS has been shut down after a good alignment and the aircraft has not been moved, a stored heading mode is removed when the alignment sequence has progressed to the point that selecting stored heading no longer reduces alignment time. At this time the STD HDG pushbutton legend is removed from the HSI display.

Ground Stored Heading Alignment Procedure

Place the INS mode selector knob to the GND position. This selects the ground alignment mode and commands the mission computer to provide a ground align display on the HI. The parking brake must be set. On the HI, press the STD HDG pushbutton. During the first one or two minutes of alignment, INS ATT is displayed. The QUAL digits start counting down and TIME digits start counting up. When the INS alignment is completed, the word OK is displayed after the QUAL number, and the TIME is less than 10 minutes.

NAVIGATION CONTROLS AND INDICATORS

HI DISPLAY

Normally, the HI displays navigation symbols and digital readouts. This information can also be displayed on the left or right DDI by pressing the MENU pushbutton and then pressing the HSI pushbutton. The symbols and digital readouts that normally appear on the HI display (figure 7-5) are as follows:

a. Aircraft symbol. The aircraft symbol represents the position of the aircraft.
b. Waypoint (WYPT) bearing pointer. The pointer indicates bearing to the selected waypoint.
c. Waypoint location symbol. The symbol represents the location of the selected waypoint.
d. Waypoint bearing (digital readout). This readout indicates the bearing to the selected waypoint.
e. Waypoint range (digital readout). This readout indicates the range to the selected waypoint.
f. Waypoint time–to–go (digital readout). This readout indicates the time–to–go to the selected waypoint.
g. Command heading marker. This marker indicates preset heading. This marker is preset with the HDG (heading) set control.
h. Ground track pointer. This pointer indicates the aircraft true ground track.
i. Ground speed (digital readout). This readout indicates ground speed.
j. True airspeed (digital readout). This readout indicates aircraft true airspeed.
k. Command heading (digital readout). This readout indicates the desired heading to the target/destination.

This is preset using the HDG (heading) set control.

l. Waypoint pushbutton. This pushbutton selects the waypoint steering for display on the HSI.

m. Up arrow pushbutton. This pushbutton, when pressed, selects the preset coordinates of the desired waypoint for display. Momentarily pressing the up arrow pushbutton increases the # (number) digital readout.

n. # (number). This digital readout indicates the waypoint selected (number zero thru ten and M1 thru M3).

o. Down arrow pushbutton. When this pushbutton is pressed, it selects the preset coordinates of the desired waypoint for display. Momentarily pressing the down arrow pushbutton decreases the # (number) digital readout.

p. O/S pushbutton. Pressing the offset pushbutton commands the mission computer system to provide steering information to an offset point from the selected waypoint.

q. POS/INS or POS/ADC or POS/TCN pushbutton. This pushbutton indicates data source that the mission computer system is using to compute the aircraft position latitude and longitude. When pressed it provides for POS option display.

r. UPDT pushbutton. Pressing this pushbutton provides for an UPDT (update) option display.

s. DATA pushbutton. Pressing the pushbutton provides for DATA option display.

POS OPTION DISPLAY

Pressing the POS/INS pushbutton on the HI commands the mission computer system to use inertial position latitude and longitude in waypoint steering computations (figure 7-5).

UPDT OPTION DISPLAY

Pressing the UPDT (update) pushbutton on the HI enables the TCN, DSG, MAP, and VEL updates on the HI (figure 7-5).

ACPT/REJ DISPLAY

During the accept/reject display on the HI there also is a display of the update source (TCN, DSG, or OVFLY) range and bearing error in present position to determine if an update is required (figure 7-5).

A/C DATA OPTION DISPLAY

Pressing the DATA pushbutton on the HI provides the following aircraft data option displays on the HI (figure 7-5):

N-S	Indicates the aircraft position latitude.
E-W	Indicates the aircraft position longitude.
WSPD	Indicates the wind speed.
WDIR	Indicates the wind direction.
MVAR	Indicates magnetic variation.

Pressing the UFC pushbutton displays the following aircraft data options on the upfront control windows and enables them for entry.

POSN	Pressing the POSN option button enables the entry of aircraft position latitude and longitude from the upfront control keyboard. Entered latitude and longitude is stored by the mission computer system and displayed on the HSI.
WSPD	When pressed, the WSPD option button enables entry of windspeed.
WDIR	When pressed, the WDIR option button enables entry of wind from direction.
MVAR	When pressed, the MVAR option button enables entry of magnetic variation.

WYPT DATA OPTION DISPLAY

Pressing the WYPT (waypoint) pushbutton provides the following waypoint data option displays on the HI (figure 7-5):

N-S	Indicates the selected waypoint latitude entered from the upfront control.
E-W	Indicates the selected waypoint longitude entered from the upfront control.
ELEV	Indicates the elevation of the selected waypoint entered from the upfront control.
O/S BRG	Indicates a true bearing angle from the selected waypoint to an offset point.
O/S RNG	Indicates a range (in thousands of feet) from the selected waypoint to an offset point.
O/S ELEV	Indicates the elevation of the offset point.
INDEX NO.	Indicates the index number (0 thru 10) under which waypoint coordinate data is entered. Up to 11 waypoints, 3 markpoints, and offsets may be entered.
UP BUTTON	Pressing the up (arrow) pushbutton increases the waypoint index number one digit.
DN BUTTON	Pressing the down (arrow) pushbutton decreases the waypoint index number one digit.

Navigation Controls and Indicators

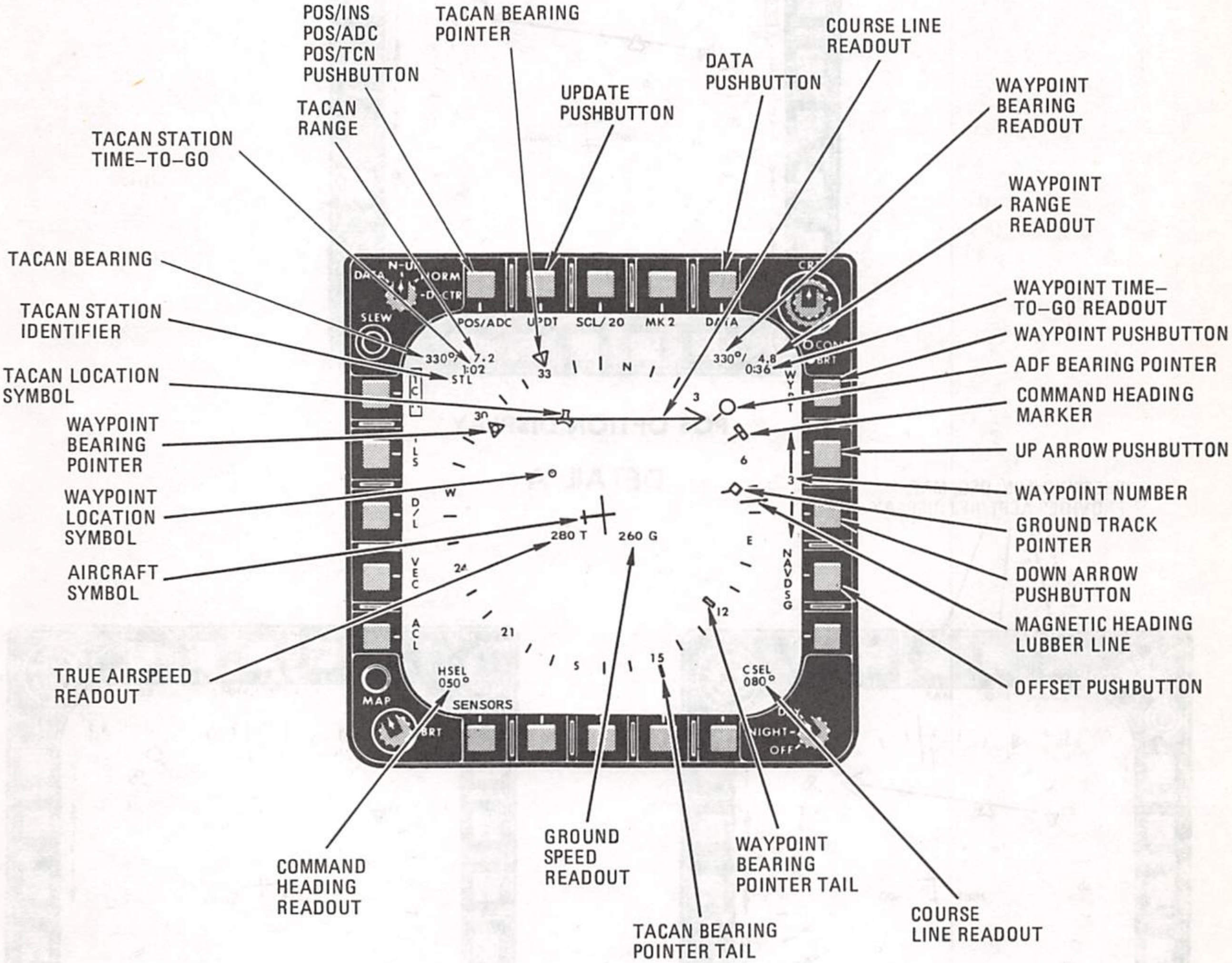

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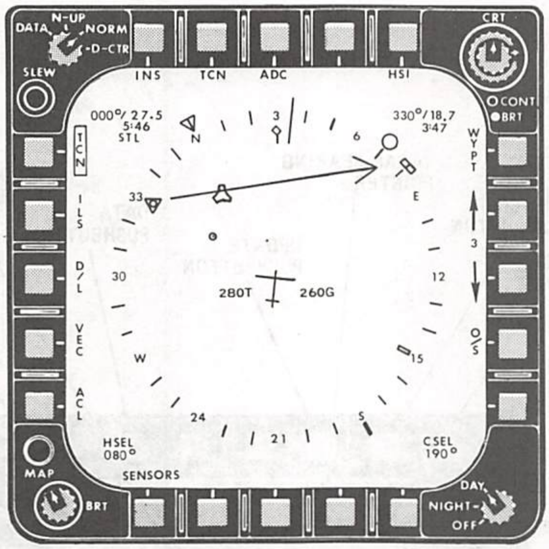
Figure 7–5. Navigation Controls and Indicators (Sheet 1 of 3)

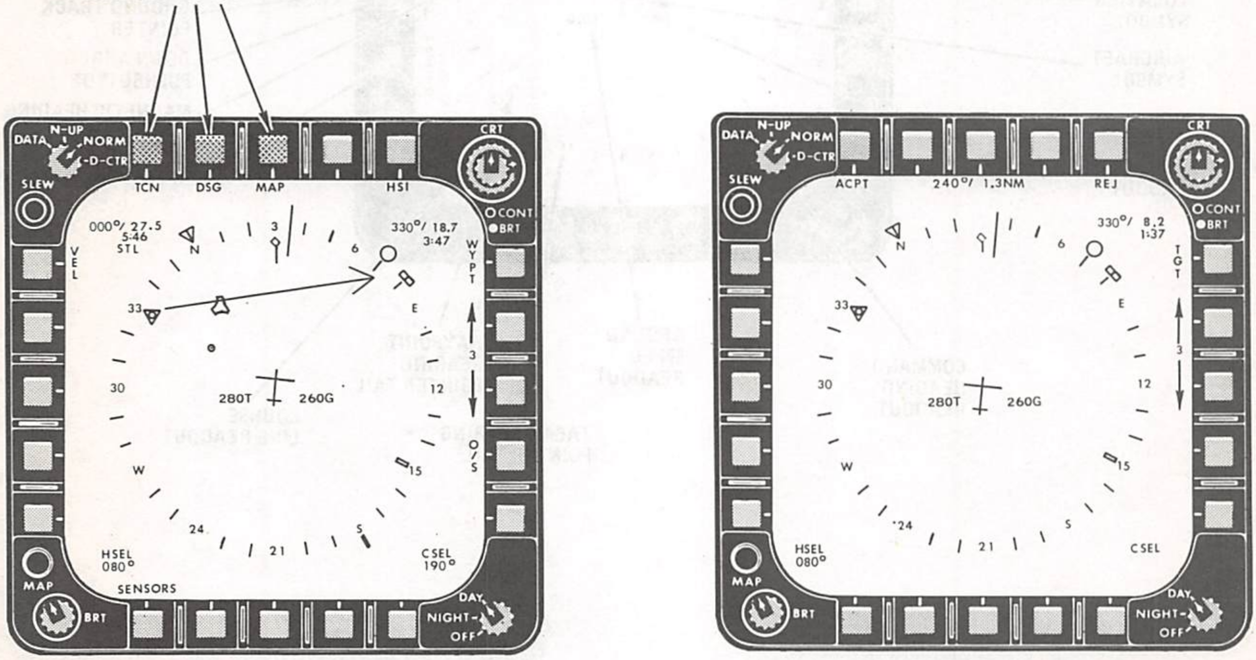
Navigation Controls and Indicators



POS OPTION DISPLAY

DETAIL A

PRESSING TCN, DSG, MAP,
PROVIDES ACPT/REJ DISPLAY



UPDT OPTION DISPLAY **ACPT/REJ DISPLAY**

DETAIL B

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Figure 7–5. Navigation Controls and Indicators (Sheet 2)

Navigation Controls and Indicators

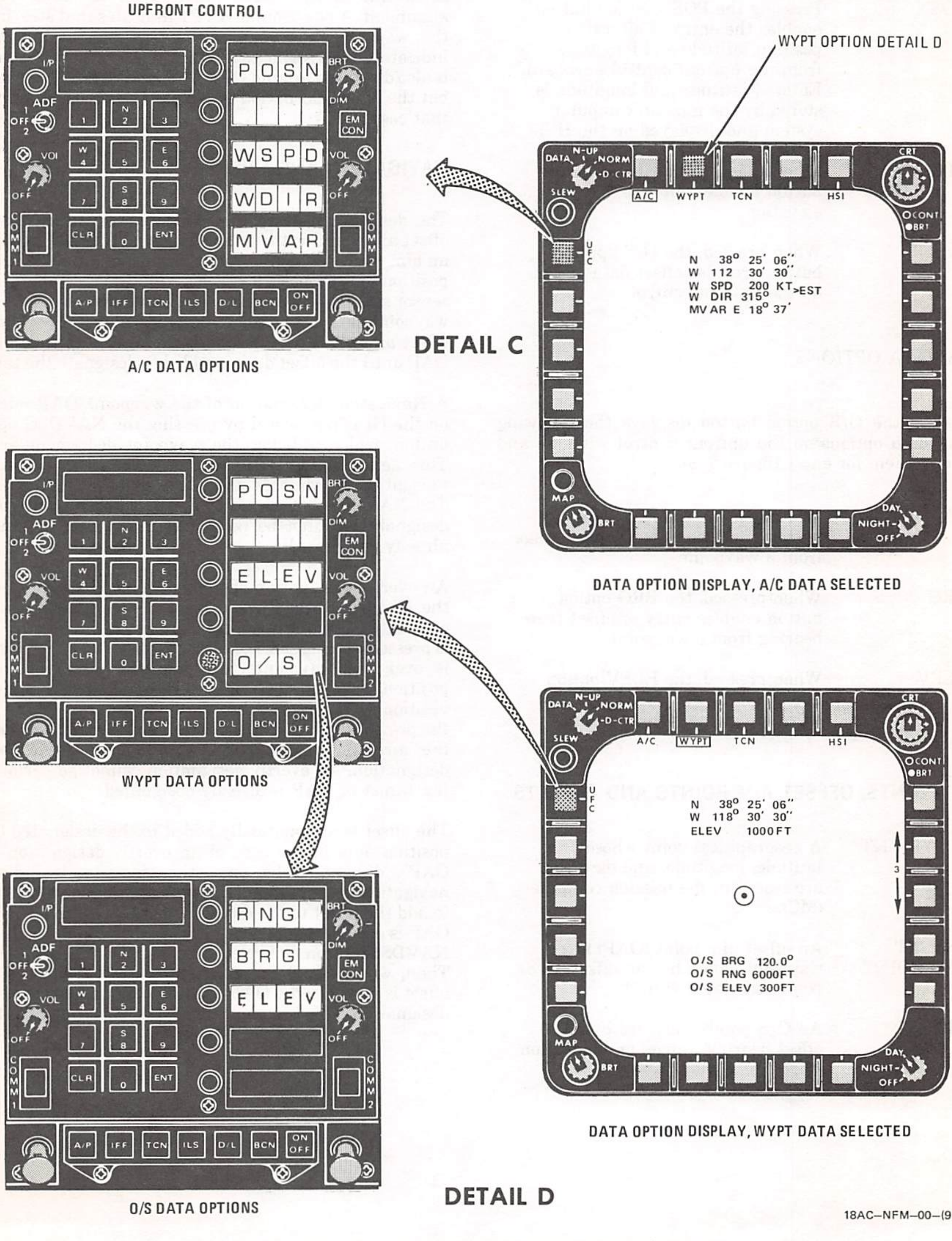

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Figure 7-5. Navigation Controls and Indicators (Sheet 3)

Pressing the UFC pushbutton displays the following waypoint data options on the upfront control windows and enables them for entry (figure 7–5):

POSN	Pressing the POSN option button enables the entry of aircraft position latitude and longitude from the upfront control keyboard. Entered latitude and longitude is stored by the mission computer system and displayed on the HSI.
ELEV	When pressed, the ELEV option button enables entry of waypoint elevation.
O/S	When pressed, the O/S option button provides offset data option on the upfront control.

O/S DATA OPTIONS

Pressing the O/S option button displays the following offset data options on the upfront control windows and enables them for entry (figure 7–5).

RNG	When pressed, the RNG option button enables entry of offset range from a waypoint.
BRG	When pressed, the BRG option button enables entry of offset true bearing from a waypoint.
ELEV	When pressed, the ELEV option button enables entry of the elevation of the offset point.

WAYPOINTS, OFFSET AIM POINTS AND OFFSETS

WAYPOINT	A geographical point whose latitude, longitude, and elevation are stored in the mission computer (MC).
OFFSET AIM POINT	An offset aim point (OAP) is a waypoint which has an offset (O/S) point associated with it.
OFFSET POINT	An O/S point is defined by an offset bearing, range, and elevation.

Up to 11 waypoints and/or OAP's can be stored in the MC, in addition to the three mark positions. The waypoint/OAP/offset data is entered via the UFC and displayed on the HI. Waypoint O is reserved for home base since this is the value provided to the INS during alignment. A box around WYPT indicates that steering to the waypoint has been selected. A box around OAP indicates that steering to the OAP has been selected. A box is also displayed around OAP when the OAP is designated, but the NAVDSG option is replaced by the O/S option in that case.

NAVIGATION AND OVERFLY DESIGNATIONS

The designation of an aim point (either a target or an offset aim point) is the action by which the pilot identifies an aim point position to the mission computer so that the position can be used for weapon delivery computations, sensor slaving, steering and/or position updating. When a waypoint is designated, it becomes a target. When an offset aim point (OAP) is designated, it is considered an OAP until the offset data is added to designate the target.

A Navigation designation of the waypoint/OAP selected on the HI is performed by pressing the NAVDSG option button, which is below the waypoint decrement arrow. This action designates the aim point based upon the navigation coordinates previously entered for the point. The NAVDSG option is not displayed and a navigation designation cannot be performed if a target or OAP is already designated.

An overfly designation of the waypoint/OAP selected on the HI is performed by pressing the throttle designator control (TDC) while it is assigned to the HI. When the TDC is pressed, the mission computer assumes that the aircraft is over the waypoint/OAP, and the aircraft present position at that time is designated as the aimpoint position. In the case of the overfly designation of an OAP, the previously stored offset data is automatically added to the aircraft present position to complete the target designation. An overfly designation cannot be performed if a target or OAP is already designated.

The offset is automatically added to the designated OAP position only in the case of an overfly designation. For OAP's designated by any other method, including a navigation designation, a separate pilot action is required to add the offset to the designated OAP position. Once an OAP is designated by any method other than overfly, the NAVDSG option is replaced by the offset (O/S) option. Then, when the O/S option pushbutton is pressed, the offset is added to the OAP position to complete the target designation. This function can also be performed HOTAS,

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by pressing the TDC while it is assigned to the HI. The aim point becomes a target when the offset is added to the OAP position.

When an OAP is designated, the OAP option on the HI is boxed and the O/S option is displayed. When a target is designated, the WYPT or OAP option is deleted and TGT is displayed in its place and boxed. When either an OAP or a target is designated, several other changes occur on the HI display. The TCN option is deselected. The waypoint symbol is removed and a target designator (TD) diamond is displayed at the position of the designated aim point. The circle in the head of the waypoint pointer is replaced by a diamond and the pointer indicates the bearing to the aim point. Also, the range, bearing and time to go to the waypoint/OAP in the upper right corner of the display are replaced by range, bearing and time to go to the designated aim point.

WAYPOINT OR OFFSET AIM POINT STEERING

Two types of waypoint steering are available. When waypoint steering is initially selected, the steering provided is direct great circle steering. Then steering along a course line can be selected if desired.

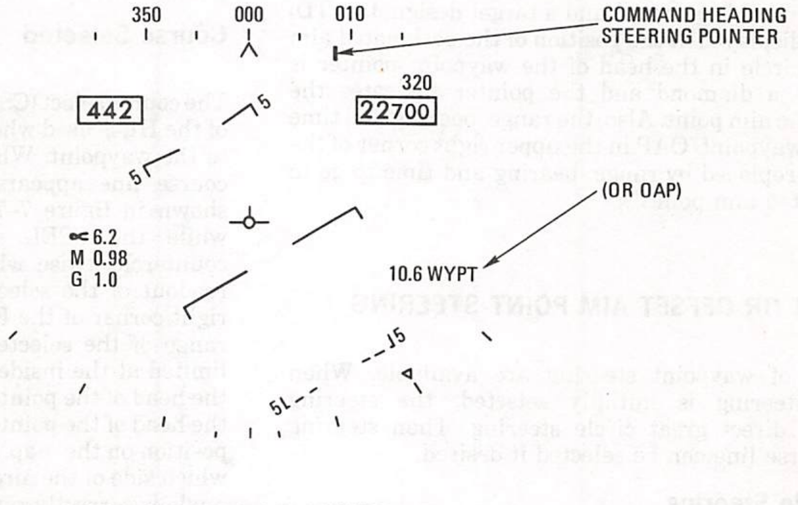
Great Circle Steering

Waypoint (or offset aim point) steering is selected by pressing the WYPT (or OAP) option on the top right corner of the HI display. When steering is selected, the option is boxed and direct great circle steering is provided on the HUD as shown in figure 7–6. To follow a direct great circle path to the waypoint, the aircraft is turned so that the command heading steering pointer under the heading scale is centered in the heading caret. The steering provided by the steering pointer is corrected for wind drift. When the steering point is within ±5° of the caret as measured on the heading scale, it provides a direct indication of steering error. Between ±5° and the ends of the heading scale (±15°), the steering pointer moves non–linearly so that it is at the end of the heading scale when the steering error is 30°. The steering pointer is displayed at the end of the heading scale when the steering error is greater than 30° to indicate the shortest direction to turn. As the steering error becomes less than 30° during a turn, the steering pointer begins to move to provide anticipation for rolling out of the turn, and then the actual steering error is indicated when within 5°. The horizontal distance (10.6 nautical miles) to the waypoint is shown on the right side of the HUD. If the waypoint were an OAP, then the range display would be 10.6 OAP. On the HI, the position of the waypoint (or offset aim point) is indicated by the waypoint symbol as shown on figure 7–6. The bearing to the waypoint (or offset aim point) is indicated by the pointer inside the compass rose. The waypoint symbol and the pointer are displayed whether or not waypoint steering is selected. They provide a navigation situation display only. Steering (corrected for drift) is provided only on the HUD. A digital readout of bearing and range to the waypoint (or offset aim point) is provided in the upper right corner of the HSD. Time to go to the waypoint in minutes and seconds, based upon range and present ground speed, is provided under the bearing and range readout.

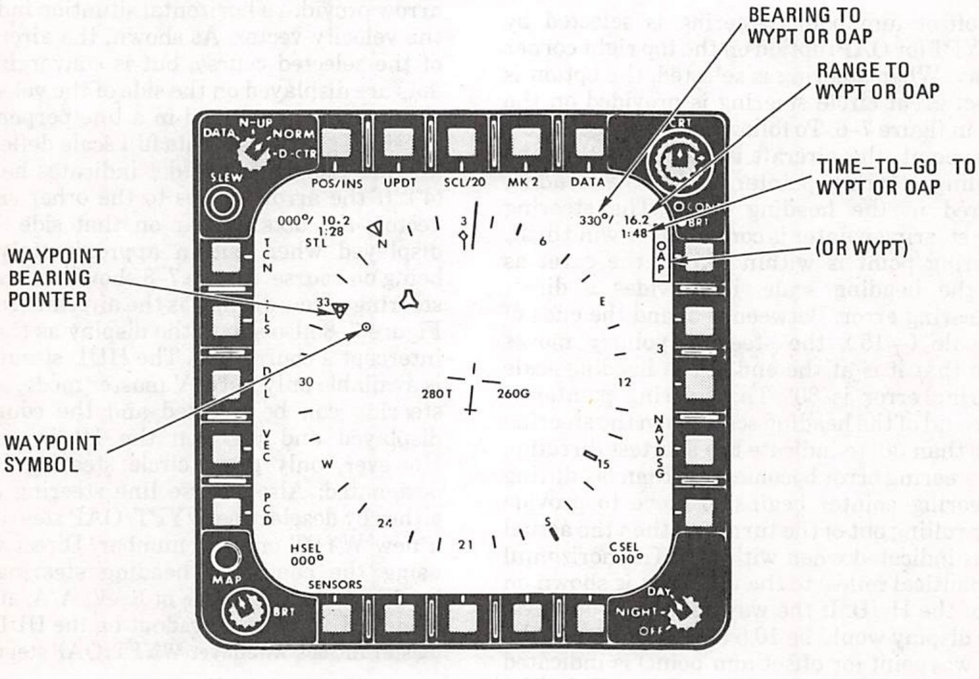
Course Selected

The course select (CSEL) switch, which is located to the left of the HI, is used when it is desired to fly a selected course to the waypoint. When the CSEL switch is actuated, the course line appears through the waypoint symbol as shown in figure 7–7. The course line rotates clockwise while the CSEL switch is held to the right and counterclockwise while it is held to the left. A digital readout of the selected course is provided in the lower right corner of the HI. When the waypoint is beyond the range of the selected HI scale, the waypoint symbol is limited at the inside of the compass rose coincident with the head of the pointer. The course line then rotates about the head of the pointer. It does not then overlay its correct position on the map. However, it does correctly indicate to which side of the aircraft the course lies and the intercept angle is correctly represented. When a course is selected, the steering on the HUD is as shown on figure 7–7. The arrow provides a horizontal situation indication relative to the velocity vector. As shown, the aircraft is to the right of the selected course, but is converging toward it. Two dots are displayed on the side of the velocity vector toward the steering arrow and in a line perpendicular to it. The outermost dot represents full scale deflection of the arrow (8°) and the innermost dot indicates half scale deflection (4°). If the arrow moves to the other side of the velocity vector, the dots appear on that side. The dots are not displayed when within approximately 1.25 degrees of being on course. Figure 7–8 shows an example of the HUD steering arrow display as the aircraft crosses a course line. Figure 7–8 also shows the display as the aircraft turns to intercept a course line. The HUD situation arrow display is available only in NAV master mode, although waypoint steering can be selected and the course arrow can be displayed and used on the HI in any master mode. However, only great circle steering is available when designated. Also, course line steering can be deselected either by deselecting WYPT/OAP steering, or by selecting a new WYPT or OAP number. Direct waypoint steering using the command heading steering pointer on the heading scale is available in NAV, A/A, and A/G master modes. The distance readout on the HUD is provided in all master modes whenever WYPT/OAP steering is selected.

Waypoint or Offset Aim Point Steering (Great Circle)



HUD STEERING DISPLAY

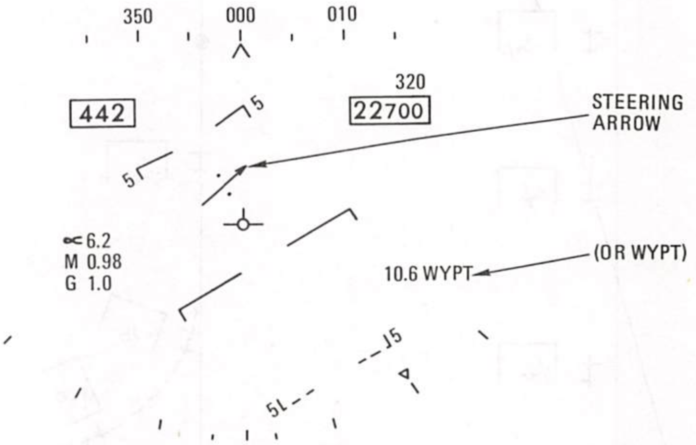


HI STEERING DISPLAY

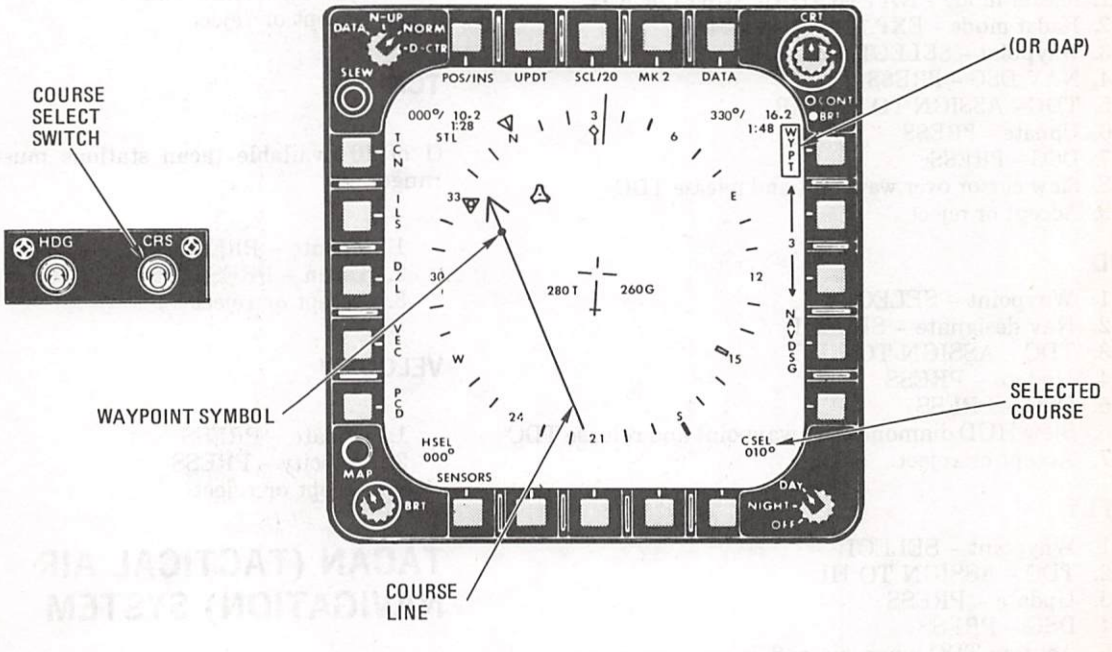
18AC–NFM–00–(127)

Figure 7-6. Waypoint Or Offset Aim Point Steering (Great Circle)

Waypoint or Offset Aim Point Steering (Course Selected)



HUD STEERING DISPLAY



HI STEERING DISPLAY

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Figure 7-7. Waypoint Or Offset Aim Point Steering (Course Selected)

HUD Steering to Course Selected

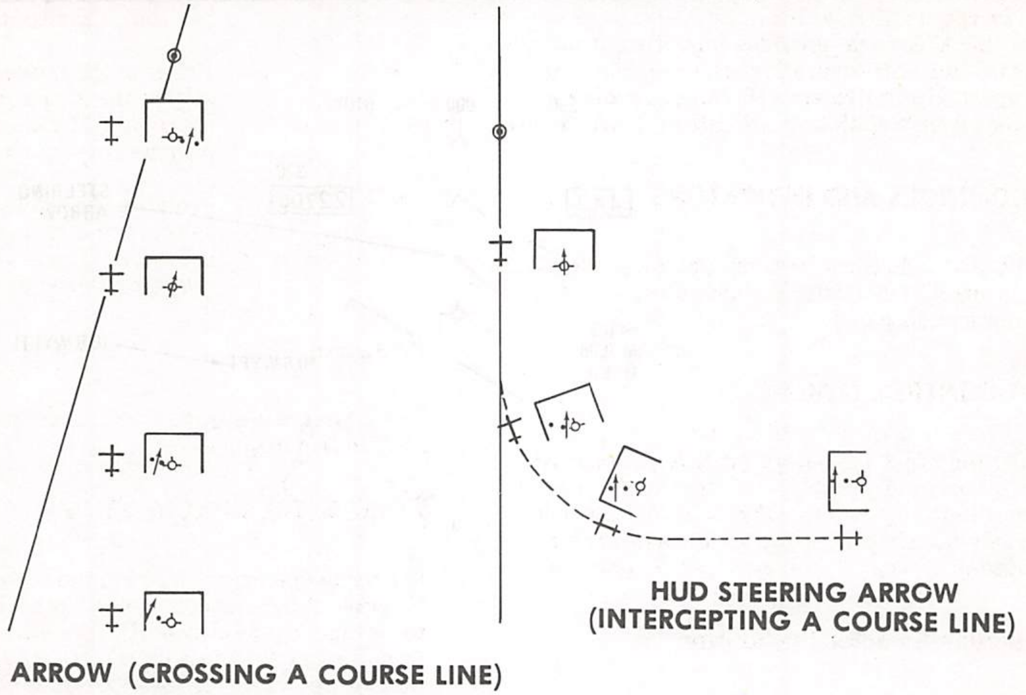
HUD STEERING ARROW (INTERCEPTING A COURSE LINE)
HUD STEERING ARROW (CROSSING A COURSE LINE)

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Figure 7–8. Hud Steering To Course Selected

INS UPDATES

RADAR

1. Master mode - NAV (RADAR SURF) or A/G.
2. Radar mode - EXP 1, EXP 2, or MAP
3. Waypoint - SELECT
4. NAV DSG - PRESS
5. TDC - ASSIGN TO RADAR
6. Update - PRESS
7. DSG - PRESS
8. Slew cursor over waypoint and release TDC
9. Accept or reject

HUD

1. Waypoint - SELECT
2. Nav designate - SELECT
3. TDC - ASSIGN TO HUD
4. Update - PRESS
5. DSG - PRESS
6. Slew HUD diamond over waypoint and release TDC
7. Accept or reject.

OVFLY

1. Waypoint - SELECT
2. TDC - ASSIGN TO HI
3. Update - PRESS
4. DSG - PRESS
5. Actuate TDC when aircraft is over waypoint
6. Accept or reject

MAP

1. Waypoint - SELECT
2. Update - PRESS
3. Map - PRESS (automatically assigns TDC to HI)
4. Overfly desired geographical reference and actuate TDC
5. Select slew and slew map reference under aircraft symbol, release TDC
6. Accept or reject

TCN

(1 of 10 available tacan stations must be in reception range)

1. Update - PRESS
2. Tacan - PRESS
3. Accept or reject

VELOCITY

1. Update - PRESS
2. Velocity - PRESS
3. Accept or reject

TACAN (TACTICAL AIR NAVIGATION) SYSTEM

The tacan system gives precise relative bearing and/or slant range distance to a tacan ground station or range to a suitably equipped aircraft. The tacan system operates in the L-Band frequency range, limiting the operating range to line of sight which depends upon aircraft altitude. The maximum operating range is 390 nautical miles when the selected tacan station is a surface beacon and 200 nautical miles when the selected tacan station is an airborne beacon. The aircraft receives a three letter audio station signal to identify the beacon being received. When operating in conjunction with aircraft having air-to-air capability, the A/A mode provides line of sight distance between two aircraft operating their tacan sets 63 channels apart. Up to five aircraft can determine line of sight distance from a sixth lead aircraft in the A/A mode.

TACAN CONTROLS AND INDICATORS

The controls and indicators for tacan operation are on the upfront control, horizontal indicator, and the intercommunication panel.

UPFRONT CONTROL (TACAN)

The pushbuttons and indicators on this panel used for tacan operation and display are the tacan function selector pushbutton, the ON/OFF selector pushbutton, the option select pushbuttons, the option display windows, the pushbutton keyboard, and the scratch pad window.

Tacan Function Selector Pushbutton

Pressing the TCN pushbutton enables tacan options to be displayed on the option display windows, enables the tacan status window to display ON if tacan is enabled, and allows the tacan channel to be displayed on the scratch pad window.

On/Off Selector Pushbutton

Pressing this pushbutton turns the tacan system on or off after first pressing the tacan function selector pushbutton. Tacan ON status disappears after 30 seconds.

Option Select Pushbuttons

The option select pushbuttons, numbered from 1 thru 5 from top to bottom, are used to select the tacan mode of operation. When tacan is enabled, a colon appears to the left of the option display windows to indicate the last mode and channel used.

T/R	Pressing the option 1 pushbutton commands the tacan receiver-transmitter (R/T) to operate in that mode. Air-to-ground range and bearing information is provided by the R/T for horizontal indicator display.
RCV	Pressing the option 2 pushbutton commands the tacan R/T to operate in air-to-ground receive mode. Bearing information is provided by the receiver for horizontal indicator display.
A/A	Pressing the option 3 pushbutton commands the tacan R/T to operate in A/A mode. Distance information is provided for horizontal indicator display.
X	Pressing the option 4 pushbutton selects the X channel for R/T operation. The channel number may be entered on the keyboard.
Y	Pressing the option 5 pushbutton selects the Y channel for R/T operation. The channel number may be entered on the keyboard.

Keyboard

The keyboard is used to enter the channel number into the scratch pad display.

HORIZONTAL INDICATOR (HI)

For tacan operation, pressing the TCN pushbutton on the HI enables tacan steering data from the digital computer to be displayed on the HI. The symbols, pointers, and displays which appear on the HI are the aircraft symbol, tacan station symbol, tacan bearing pointer, tacan course pointer, and the various digital tacan displays. See figure 7-9 for typical tacan display. The aircraft symbol represents the aircraft position and the tacan station symbol represents the tacan station position. When read in respect to the aircraft symbol, the station symbol gives the relative position of the aircraft from the station. The tacan bearing pointer indicates the tacan bearing to the selected tacan station. The tacan course pointer indicates the course to/from the selected tacan station. The digital tacan displays which appear on the HI are the range, bearing, and time-to-go to the station, and a three letter code representing the tacan station to which range and bearing is being supplied.

TACAN VOLUME CONTROL KNOB

This knob is on the intercommunication panel on the left console, and it adjusts the volume of the tacan identification tone.

COURSE SET SWITCH

The course set switch (CRS), which is to the left of the horizontal indicator, is used to set a predetermined course to be steered to the tacan station.

EMISSION CONTROL PUSHBUTTON

The emission control pushbutton is on the right side of the upfront control and is labeled EMCON. Pressing the pushbutton puts the tacan in a non-transmitting mode by switching the system to a receive mode if it is in the transmit/receive or air-to-air mode. At the same time EMCON is displayed vertically on the option display windows. When emcon is turned off by pressing the

TACAN Display

TYPICAL

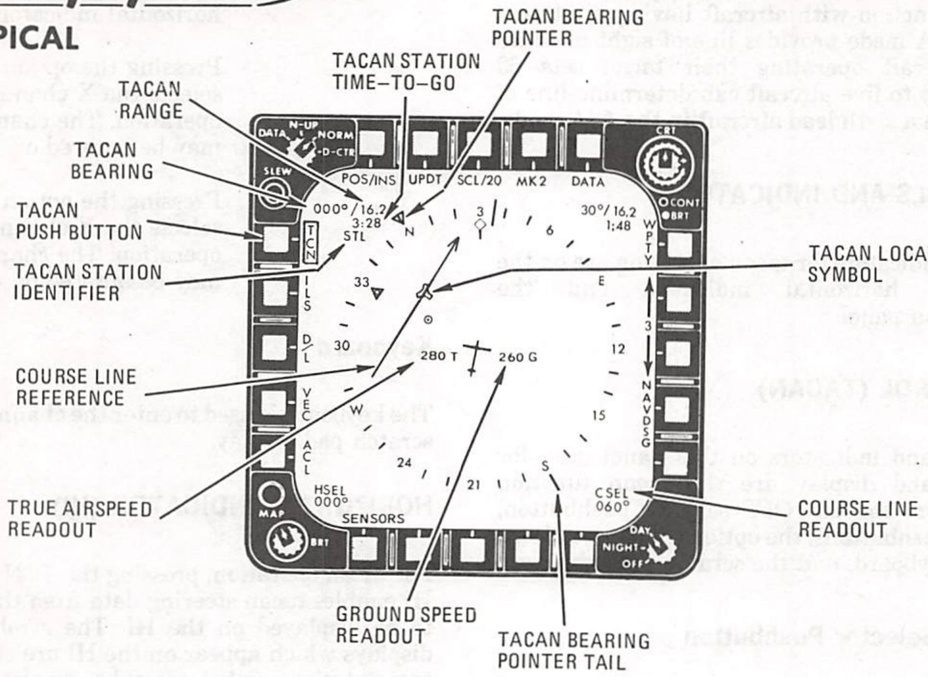

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Figure 7-9. Tacan Display (Typical)

pushbutton again, the tacan returns to its previous operating mode.

TACAN BIT CHECKS

To manually initiate a tacan BIT check, ensure the tacan is turned on, then press the TCN/IFF pushbutton on the BIT display on the DDI. If the tacan is good, the DDI will show the BIT status as GO. If the tacan does not pass the BIT check, the BIT status will show DEGD. The tacan system also has an automatically initiated BIT. If the automatic BIT check detects a wrong signal or a failure, a tacan DEGD is displayed on the DDI BIT display and the BIT line on the left DDI. If no fault is detected, nothing is displayed next to TCN.

TACAN STATION DATA ENTRY

To make a tacan station data entry, press the DATA pushbutton on the HI (see figure 7-10). Press the TCN pushbutton and the display changes to the tacan data display. To select the desired tacan station selection number, use the increment (up arrow) or decrement (down arrow) pushbuttons. The station data selection numbers, 0 to 9, represent the 10 prestored tacan station data entries. Press the UFC pushbutton and the tacan data options are displayed on the upfront control as listed below:

a. CHAN
b. X/Y
c. POSN
d. ELEV
e. MVAR

To enter new data, press the applicable option select pushbutton on the upfront control. The data can then be entered by using the keyboard and then pressing the ENT pushbutton. The data is displayed on the scratch pad window until the ENT pushbutton is pressed and the data is entered. The tacan data table for storing 10 tacan stations can be used for tacan position keeping or for INS positiion update.

TACAN POSITION KEEPING

When tacan is to be used for aircraft present position keeping, the tacan system must be on. On the upfront control, press the T/R mode option select pushbutton. Select the proper X or Y channel of the tacan station to be used by pressing the applicable option select pushbutton. Enter the channel number using the keyboard and then pressing the ENT pushbutton. The tacan station used must be 1 of the 10 prestored tacan stations. On the HI, press the POS pushbutton (see figure 7-11) and then push the TCN pushbutton. The POS pushbutton on the HSI display now reads POS/TCN indicating that the tacan data is being used for position keeping.

TACAN STEERING

The tacan steering is always course line steering. It is identical to the course line waypoint steering. Tacan steering is selected by pressing the TCN option button on the top left corner of the HI display. When TCN steering is selected, the option is boxed and the course line is displayed on the HI as shown in figure 7-12. At the same time, steering is provided on the HUD. The HUD steering arrow provides tacan course line steering in the same manner as for waypoint

TACAN Station Data Entry

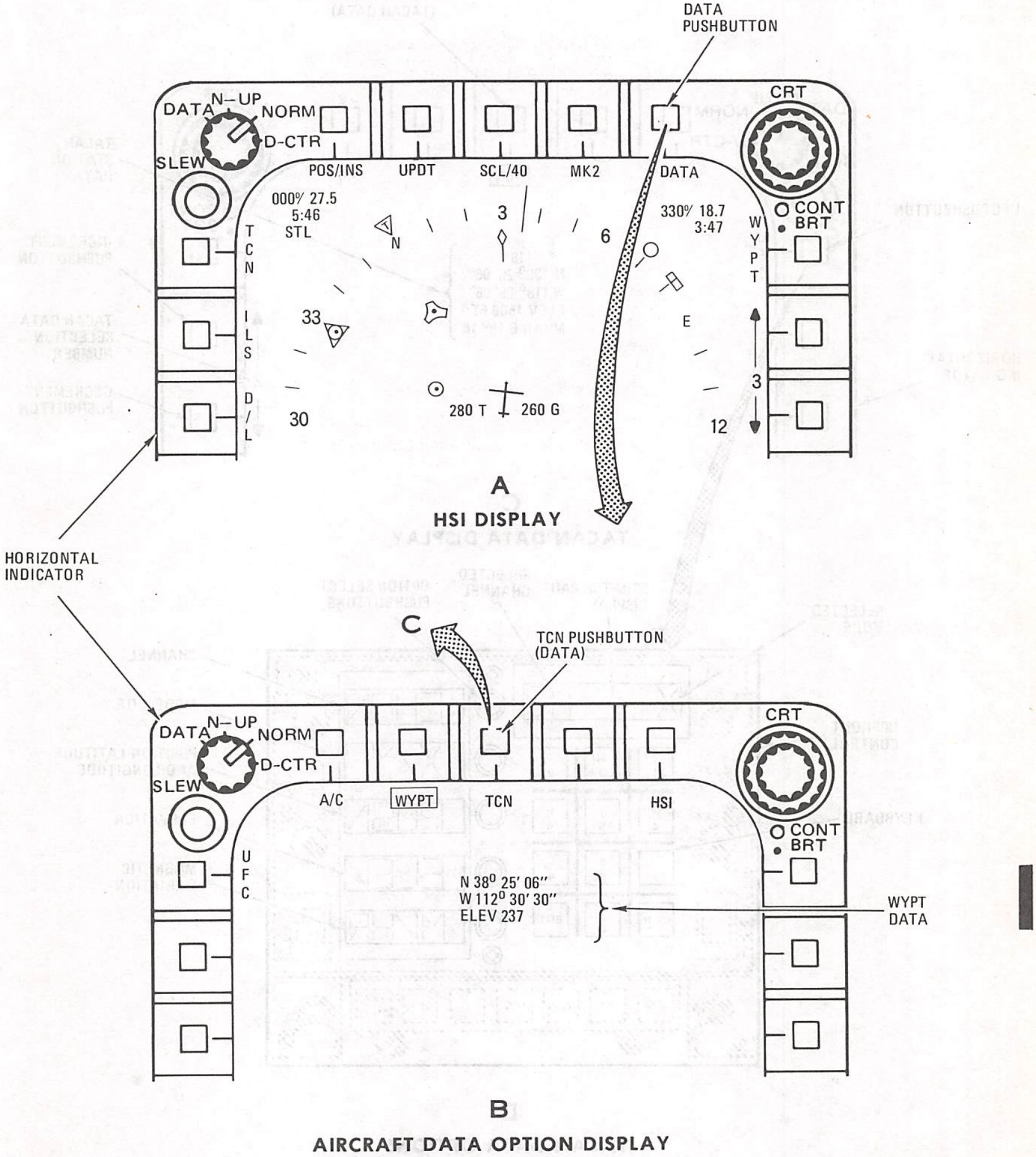

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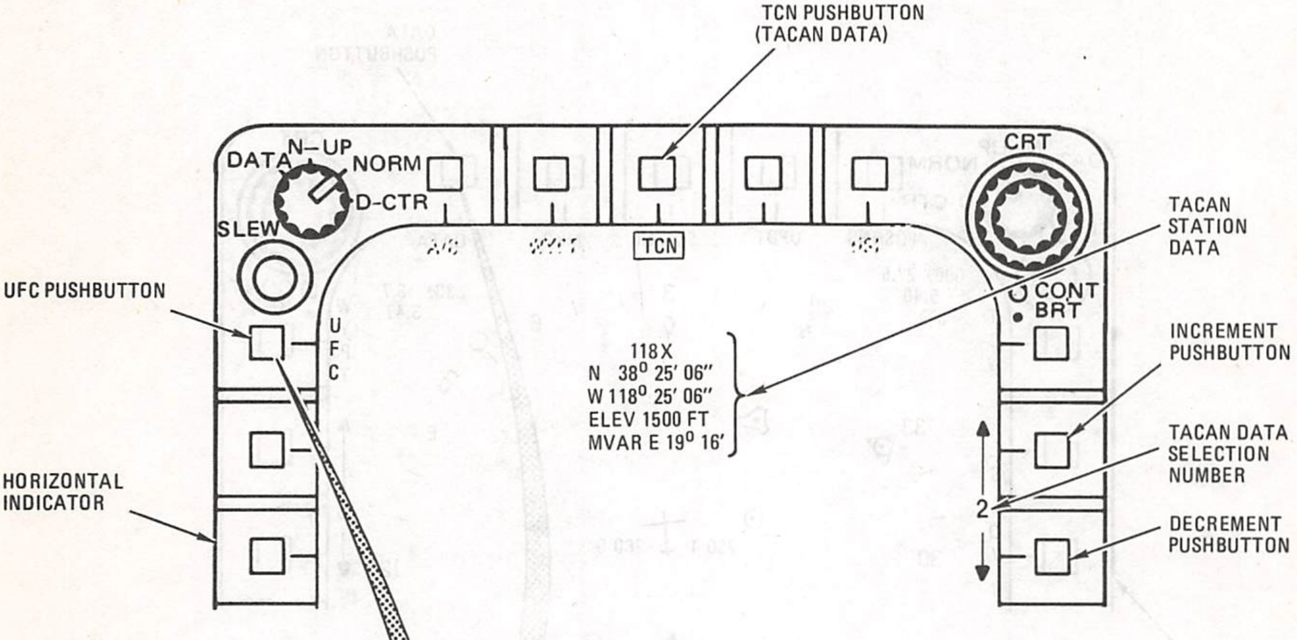
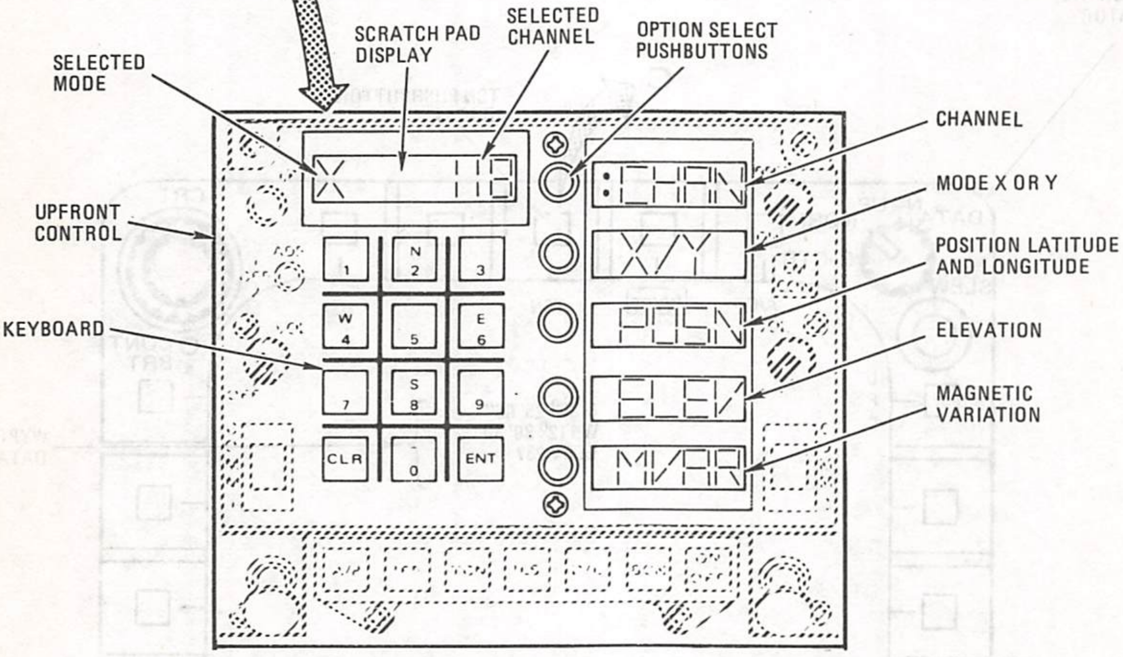
Figure 7-10. Tacan Station Data Entry (Sheet 1 of 2)

TACAN Station Data Entry



C

TACAN DATA DISPLAY



D

TACAN DATA OPTIONS

18AC-NFM-00-(113-2)

Figure 7-10. Tacan Station Data Entry (Sheet 2)

TACAN Position Keeping

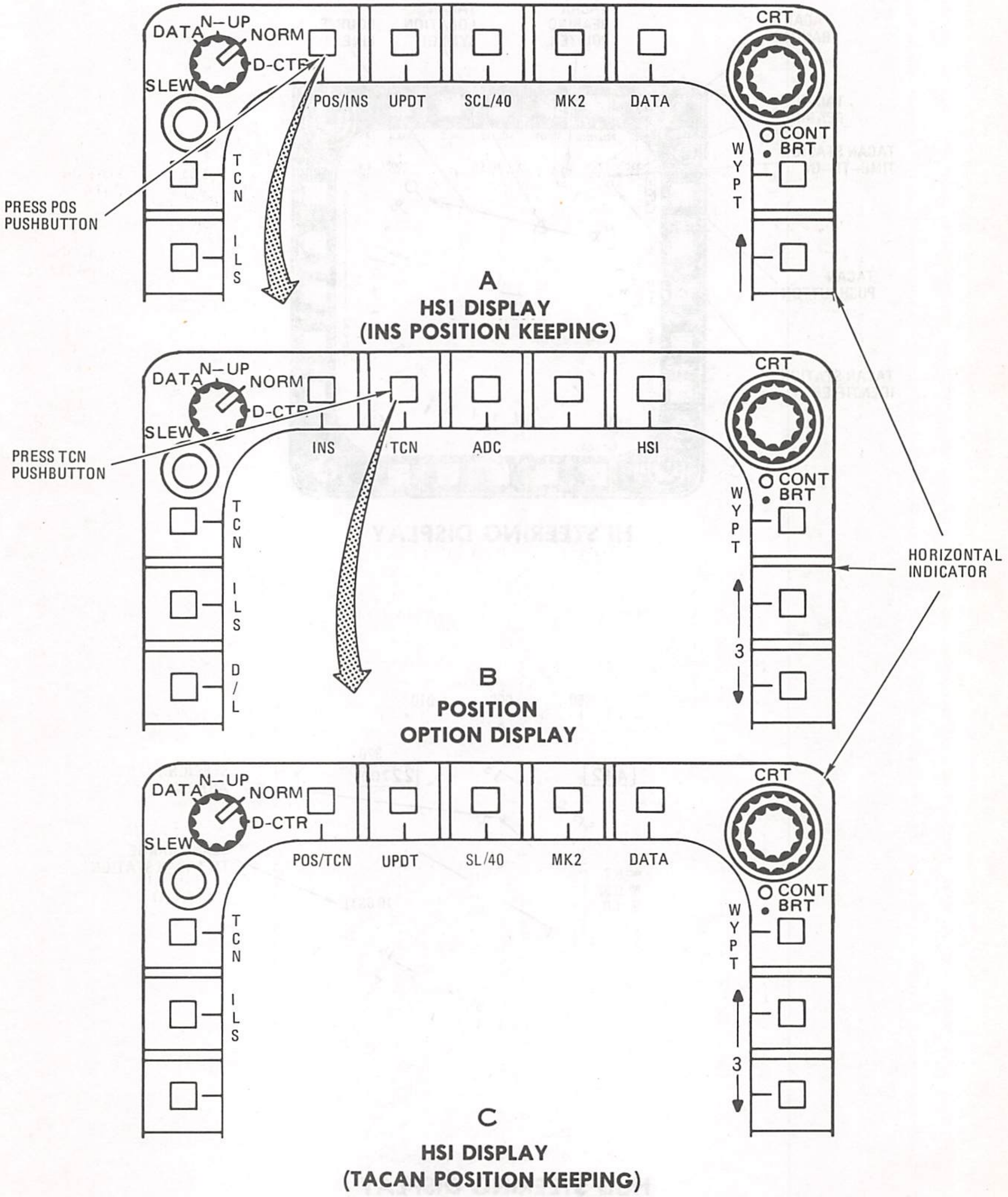


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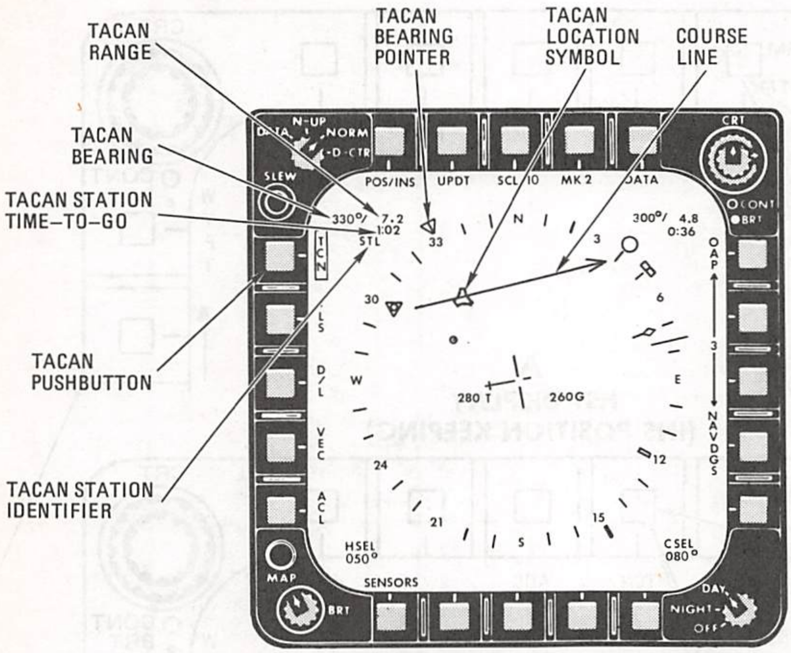
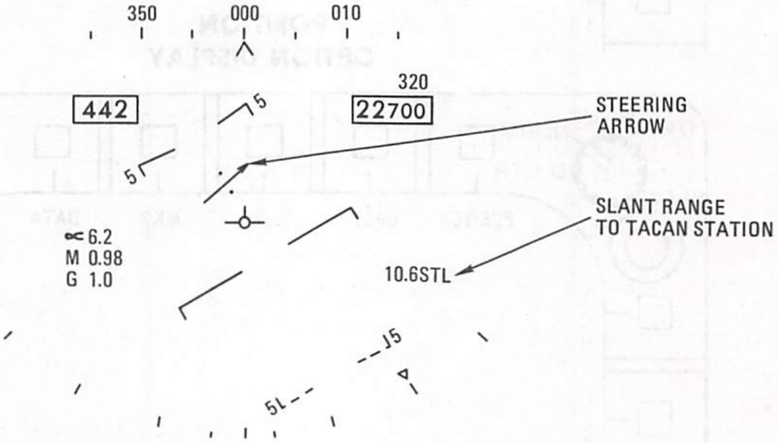
Figure 7-11. Tacan Position Keeping

Tacan Steering Displays



HI STEERING DISPLAY



HUD STEERING DISPLAY

18AC–NFM–00–(123)

Figure 7–12. Tacan Steering Displays

steering. The examples shown in figure 7-12 apply for tacan steering as well as waypoint steering. On the HI, the position of the tacan station is indicated by the tacan symbol. The bearing to the station is indicated by the pointer outside the compass rose. The tacan symbol and the pointer are displayed whether or not tacan steering is selected. A digital readout of bearing and distance to the station is provided in the upper left corner of the HI. Time to go to the station in minutes and seconds, based upon distance and present ground speed, is provided under the bearing and distance. The station identifier is displayed under the time. The course line is displayed through the tacan station symbol whenever TCN steering is selected. The course arrow is controlled with the course selector (CSEL) switch to the left of the HI as described for waypoint steering. The tacan station symbol is limited at the inside of the compass rose when the tacan is beyond the selected HI range scale. When it is limited, the course line does not overlay its correct position on the map. However, when compared with the aircraft symbol, it does correctly indicate to which side of the aircraft the course lies and the intercept angle is correctly represented. The distance readout on the HUD and the HI is the DME slant range to the station. The morse code station identifier is displayed when it is decoded by the CSC. If the identifier is not again received and decoded within 45 seconds, it is blanked. Tacan steering can be selected and the course arrow can be used on the HI in any master mode. However, the HUD tacan display is available only in NAV master mode, although the distance readout and identifier are provided on the HUD in all master modes when TCN steering is selected. When a tacan position update or tacan position keeping is in progress, tacan steering is not active, since the MC is continuously sequencing through the tacan stations stored in the table.

TACAN UPDATE

When using tacan for updating aircraft present position, the tacan system must be on in the T/R mode and the station used must be prestored. On the HI, press the UPDT pushbutton (see figure 7-13), and then press the TCN pushbutton. The HI displays present position error in degrees and nautical miles. The present position error is used to update the aircraft present position by pressing the ACPT pushbutton. If aircraft present position update is not desired, press the REJ pushbutton. The HI reverts to the HSI display when the REJ pushbutton is pressed.

ADF SYSTEM

The ADF is a VHF/UHF direction finder operating in the 100 to 400 MHZ frequency range. The system has two sections. The antenna section receives and modulates rf signals. The audio processing section resolves the bearing in the ADF audio received from the VHF/UHF receiver-transmitter. The channel of the station to which ADF bearing is required is selected on the comm 1 or comm 2 receiver-transmitter and the ADF system sends bearing information to the mission computer system. The mission computer uses ADF information to position the ADF bearing symbol (a small circle) on the HSI display. The bearing symbol position on the HSI display shows the bearing of the selected station in relation to aircraft position. An audio signal is also heard in the headsets and can be adjusted with the comm 1 or comm 2 volume controls.

INSTRUMENT LANDING SYSTEM

The instrument landing system AN/ARA-63A (ILS) is an all weather approach guidance system which operates with an aircraft carrier installed transmitting set AN/SPN-41. The ILS decodes transmitted azimuth and elevation signals during an aircraft approach and provides steering information to be displayed on the head-up display unit (HUD) and/or the attitude reference indicator. The major components of the AN/ARA-63A system are a receiver and a decoder.

ILS RECEIVER

The ILS receiver receives coded transmissions of azimuth and elevation guidance data from the surface transmitters. The receiver transforms these signals to coded pulses suitable for processing in the decoder. A BIT module for system BIT check is contained within the receiver.

ILS DECODER

The ILS decoder receives and decodes the azimuth and elevation pulses from the receiver, and converts them to azimuth and elevation command signals for the HUD and/or the attitude reference indicator.

ILS CONTROLS AND INDICATORS

The controls and indicators for the ILS are the upfront control, left or right digital display indicator (DDI), horizontal indicator, head-up display unit (HUD),

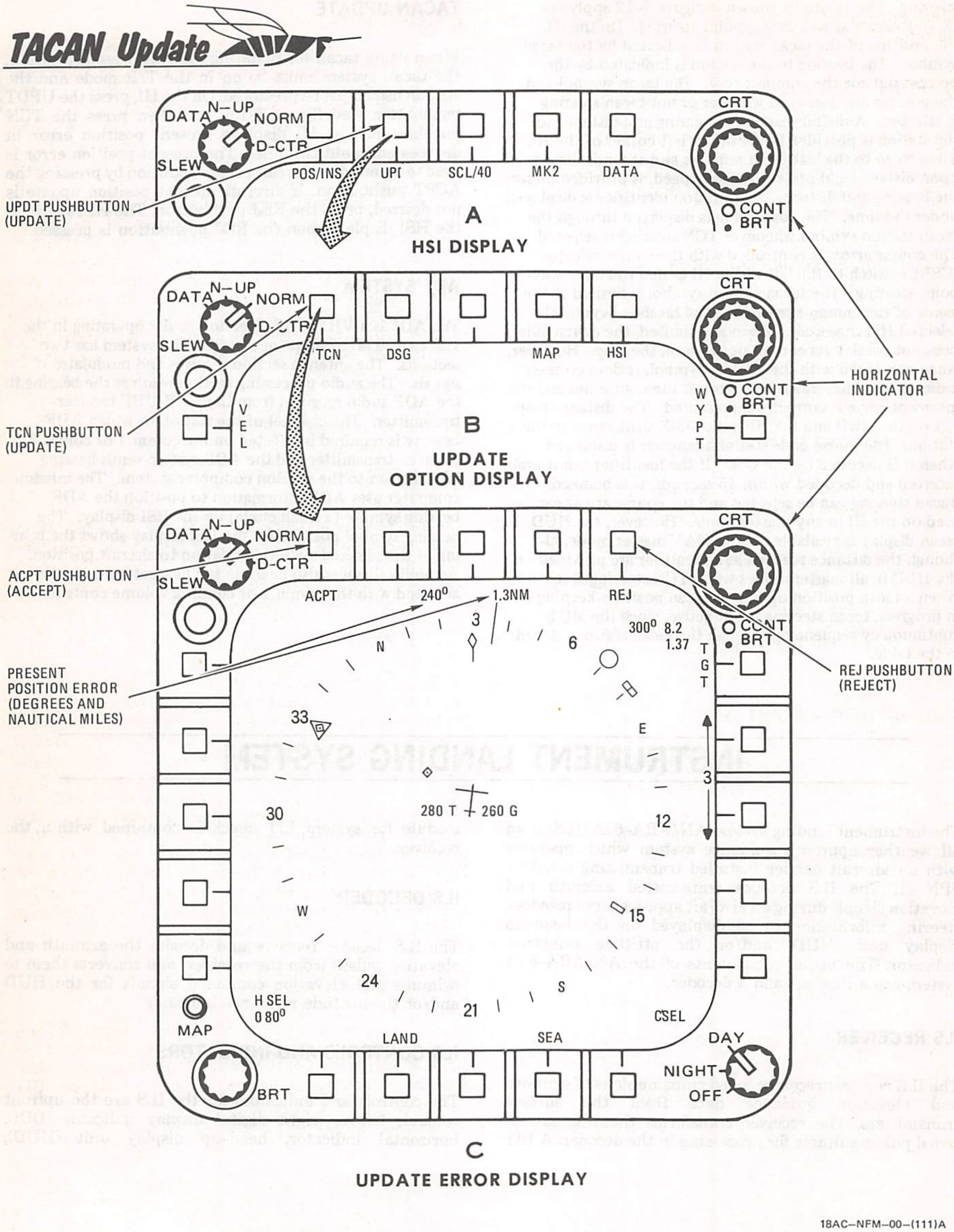


Figure 7-13. Tacan Update

intercommunication panel, and the attitude reference indicator.

UPFRONT CONTROL

The pushbuttons and indicators on this control used for ILS operation and display are the ILS function selector pushbutton, the ON/OFF selector pushbutton, the option display windows, the pushbutton keyboard, and the scratch pad window.

ILS Function Selector Pushbutton

Pressing this pushbutton enables ILS CHNL option to be displayed on the option display windows; enables the ILS status window to display ON if the ILS is enabled; and allows the ILS channel to be displayed on the scratch pad window.

ON/OFF selector pushbutton

Pressing this pushbutton turns the ILS system on or off after first pressing the ILS function selector pushbutton.

HORIZONTAL INDICATOR (HI)

Pressing the ILS pushbutton on the HI display enables azimuth and elevation steering information from the digital computer to be displayed on the HI and the HUD.

HEAD-UP DISPLAY UNIT (HUD)

When ILS is selected on the HI, ILS steering modes (azimuth and elevation) are provided on the HUD (figure 7-14).

INTERCOMMUNICATION PANEL

For ILS operation the intercommunication panel contains an ILS UFC/MAN switch and two ILS channel thumbwheels.

ILS UFC/MAN Switch

This is a two-position toggle switch with positions of UFC and MAN. When the switch is in the UFC position, ILS power and channel selection is controlled by the upfront control. When in the MAN position, ILS power is enabled.

ILS Channel Thumbwheels

These two thumbwheels are labeled ILS CHANNEL and are used to select the ILS channel when the ILS UFC/MAN switch is set to MAN (manual).

ILS STEERING

When the instrument landing system is on and the ILS option button on the left side of the HI is pressed, the ILS option is boxed and ILS steering display shown in figure 7-15 is enabled on the HUD. The elevation and azimuth deviation needles are referenced to the velocity vector. As shown, the needles are deflected full scale and the aircraft is below glide slope and to the left of course. The azimuth needle is deflected full scale for azimuth deviations of ±6° to ±20°. The elevation needle is deflected full-scale down for elevation deviations of 1.4° to 20°, and full-scale up for deviations of −1.4° to −3°. If a valid azimuth or elevation signal is not received by the ILS, then the corresponding needle is not displayed.

ILS MODES OF OPERATION

The ILS can be activated by three modes of operation. These three modes are primary mode, backup mode, and ACL (automatic carrier landing) mode. The ACL mode is described separately in this section.

Primary Mode

In the primary mode (figure 7-15) the upfront control is used to control the ILS. To activate the ILS, press the ILS function selector pushbutton, then press the ON/OFF selector pushbutton. The last ILS channel number selected and the on/off status of the ILS appear on the scratch pad window. The CHNL (channel) mode is automatically selected and a colon appears beside the CHNL option. To enter new channel numbers (1 to 20) press the pushbutton on the keyboard. To initiate BIT, press the ILS/AUG/BCN pushbutton on the left or right DDI BIT control display. To display ILS steering on the HUD, press the ILS pushbutton on the HI. To turn off the ILS, press the ILS function selector pushbutton then press the ON/OFF selector pushbutton.

Backup Mode

In the backup mode (figure 7-15) the intercommunication panel is used to control the ILS. To activate the ILS, set the ILS UFC/MAN switch to MAN. Channel number 1 thru 20 is then selected with the two thumbwheel switches. BIT

ILS Steering Displays

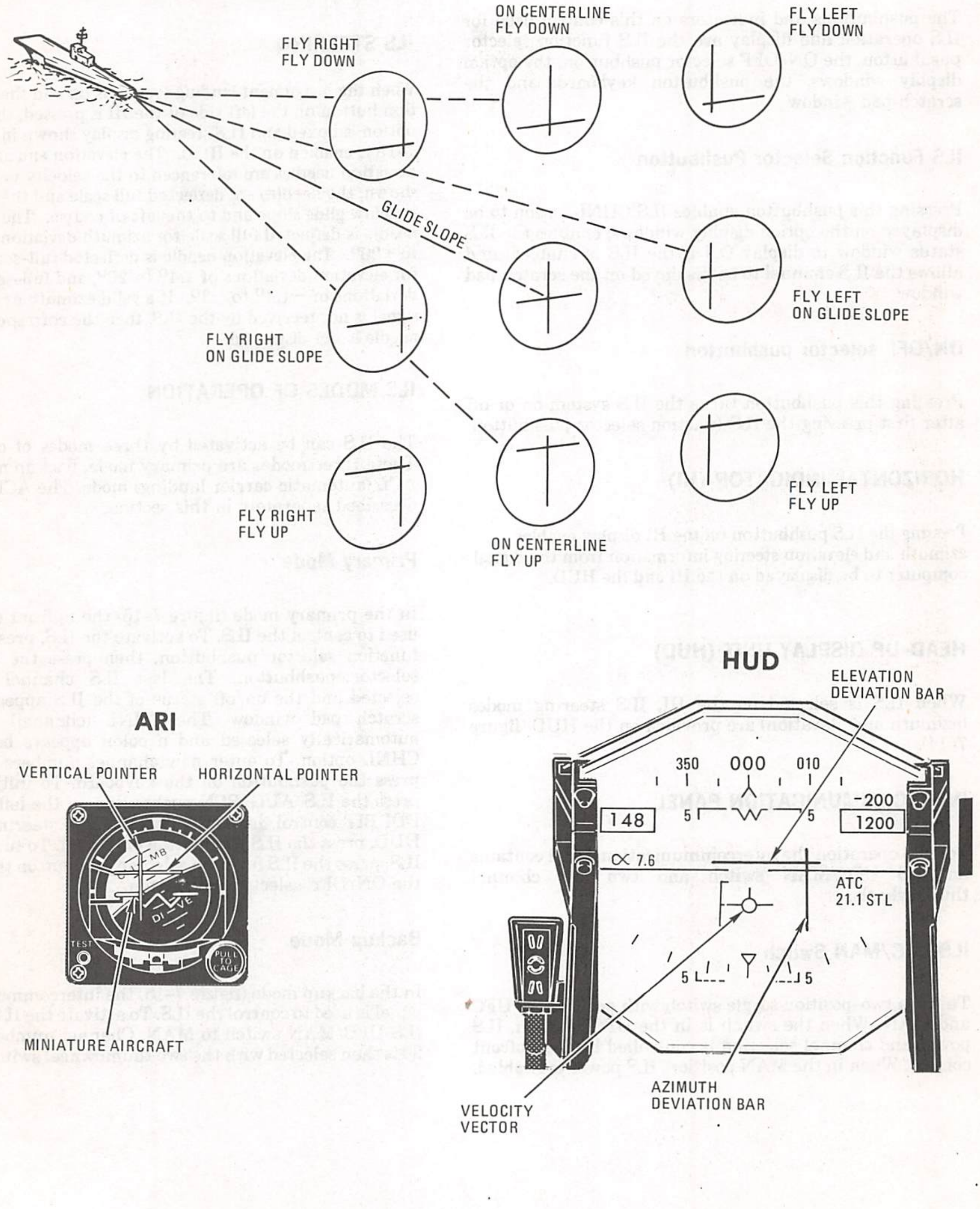
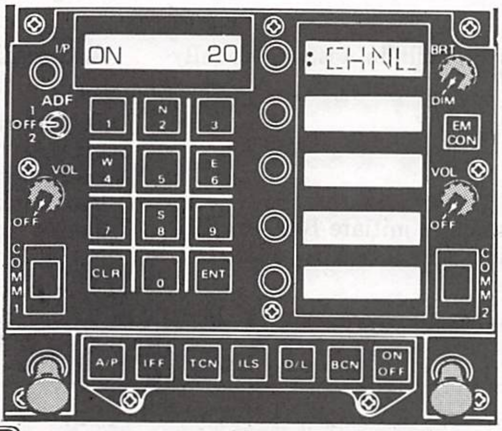
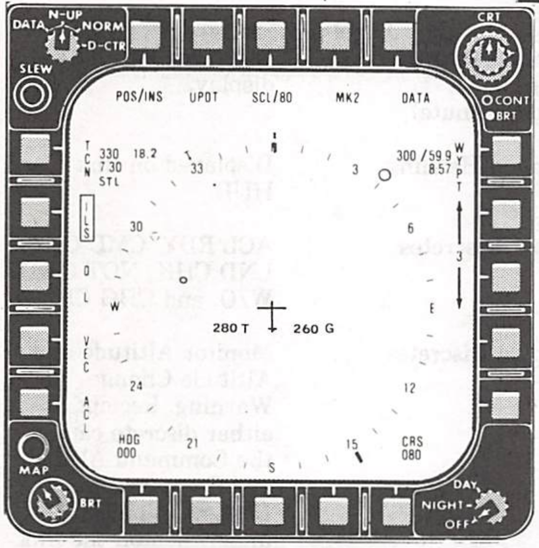


Figure 7-14. ILS Steering Displays

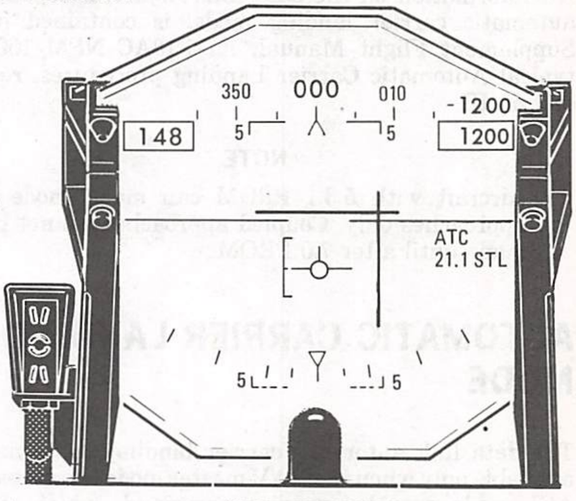
ILS Modes



UPFRONT CONTROL

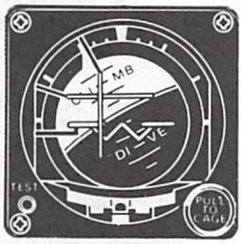


HORIZONTAL INDICATOR

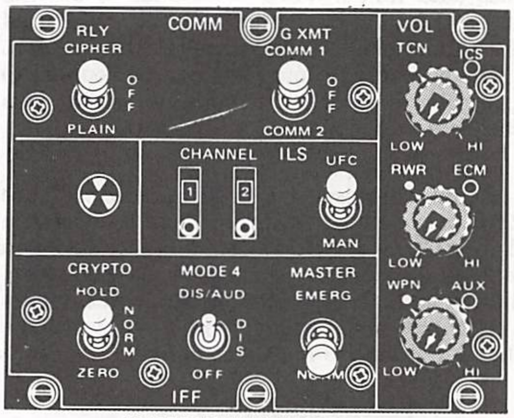


HEAD-UP DISPLAY

PRIMARY MODE



ATTITUDE REFERENCE INDICATOR



INTERCOMMUNICATION PANEL

BACKUP MODE

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Figure 7-15. ILS Modes

checks are not performed in the backup mode.

BIT CHECKS

The ILS has two methods of built-in tests: manually initiated and automatic BIT.

Manual BIT

With the ILS turned on, manually initiate BIT from the left or right DDI by pressing the ILS/AUG/BCN/D/L pushbutton on the BIT display. If any of the BIT monitored outputs fail, a BIT status message DEGD (degraded) appears on the BIT display on the DDI. If the BIT checks are good, the letters GO are displayed on the DDI.

Automatic BIT

To perform an automatic BIT check, the ACL pushbutton must be pressed on the HI and the aircraft must be operating in the navigational master mode. The ILS will automatically be turned on and a BIT check run. The BIT display is the same as the manually run BIT check.

DATA LINK SYSTEM

All information on the data link system, except for the automatic carrier landing mode, is contained in the Supplement Flight Manual, A1-F18AC-NFM-100. For typical Automatic Carrier Landing procedures, refer to section III.

NOTE

Aircraft with 5.3.1 PROM can make mode 2 approaches only. Coupled approaches cannot be made until after 7.0 PROM.

AUTOMATIC CARRIER LANDING MODE

The data link automatic carrier landing (ACL) mode is available only when the NAV master mode is selected. The ACL mode provides steering commands which may be coupled to the flight control computer for fully automatic approaches to touchdown, or the pilot may elect to use the steering displays for a manually controlled landing. The traffic control (T/C) mode is a submode of ACL. The T/C mode provides data link heading commands to aid the pilot in reaching the marshal point and/or it may be used for azimuth alignment from marshal until ACL acquisition. These heading commands can be coupled to the flight control computer for automatic lateral axis control or can be used for manual steering aids.

Two uplinked control messages (label 5 and label 6) are uniquely addressed to a specific aircraft and received via the data link for ACL mode (and T/C submode) control and display. The label 5 message only is used for T/C mode, while both label 5 and label 6 are required for ACL modes 1, 1A, and 2 control and display. The contents of the uplinked label 5 and label 6 messages follows:

Label 5 Message

Command Altitude (feet)	Displayed on link 4 display.
Command Airspeed (knots)	Displayed on link 4 display.
Command Rate of Descent (feet per minute)	Displayed on link 4 display.
Command Heading	Displayed on link 4 and HUD.
Group 1 Discretes	ACL RDY, CMD CNT, LND CHK, NOT CMD, W/O, and CHG CHNL.
Group 2a Discretes	Monitor Altitude and Altitude Change Warning. Receipt of either discrete causes the Command Altitude and Command Rate of Descent to be underlined on the link 4 display.
Group 2b Discretes	Monitor Speed and Speed Change Warning. Receipt of either discrete causes the Command Airspeed to be underlined on the link 4 display.
Group 2c Discretes	ADJ A/C, VOICE and 10 SEC.

Label 6 Message

Vertical Glide Slope Error	Used for data link HUD situation display.
Lateral Glide Slope Error	Used for data link HUD situation display.
Mode Status Discrete	Indicates that uplinked longitudinal and lateral axes commands may be used for mode 1 approach.

Label 6 Message	
Longitudinal Axis Command (altitude rate in ft/sec)	Used by FCS for longitudinal axis control.
Lateral Axis Command (roll angle in degrees)	Used by FCS for lateral axis control.

The ground station also periodically uplinks two universal test messages (UTM–3A and UTM–3B). These two messages have a canned constant content and carry a universal address, rather than being addressed uniquely to a controlled aircraft, as are the label 5 and label 6 messages. During ACL mode test, the data link is commanded to accept these two UTM as part of the determination of onboard ACL capability.

ACL MODE DISPLAYS

The ACL mode displays consist of the link 4 display on the left DDI and the data link situation display on the HUD. The following paragraphs contain a general description of the displays related to the ACL mode. A more explicit definition of the utilization of these displays is presented in ACL Mode Operation, this section.

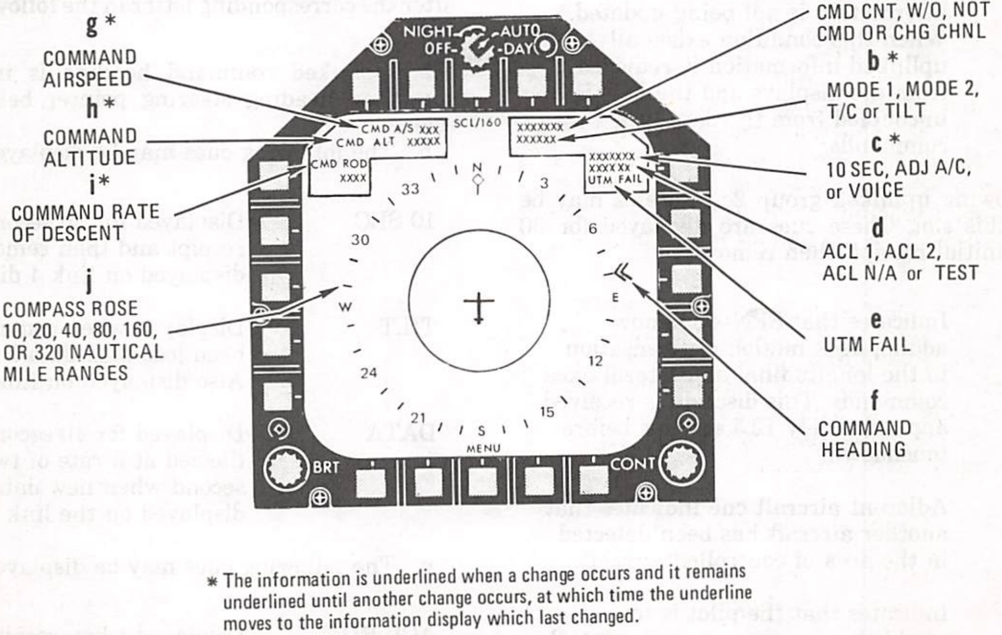
Link 4 Display

Figure 7–16 shows the ACL and T/C information which may be displayed on the link 4 display. The lettered symbols and cues on the display are described after the corresponding letter in the following paragraphs.

a. The following uplinked group 1 discretes may be displayed in this slot.

LND CHK	Landing check indicates that SPN–42 control radar communication has been established. It also cues the pilot to be in the landing configuration with ATC engaged.
ACL RDY	ACL ready indicates that SPN–42 acquisition has occurred and uplinked longitudinal axis (altitude rate) and lateral axis (roll rate) commands are being received equal to zero. The ACL RDY indication is also displayed on the HUD. Receipt of the ACL RDY discrete is one of the onboard prerequisites for ACL couple.
CMD CNT	Command control discrete indicates that the carrier has received a verbal confirmation from the pilot that FCS is coupled to the ACL longitudinal and lateral commands, and further indicates to the pilot that longitudinal and lateral commands are now active.

DDI Link 4 ACL Display



* The information is underlined when a change occurs and it remains underlined until another change occurs, at which time the underline moves to the information display which last changed.

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Figure 7–16. DDI Link 4 ACL Display

W/O	The waveoff discrete indicates that the pilot is to terminate the approach and go around. When this discrete is received the FCS is uncoupled from the uplinked commands and the flashing break X is displayed on the HUD.
NOT CMD	The not command discrete indicates that label 5 information is invalid. When this discrete is received the label 5 information is removed from the link 4 display and the FCS is uncoupled from the T/C heading command/ACL steering commands.
CHG CHNL	The change channel discrete indicates that the data link frequency should be change.

b. The following ACL mode operational cues may be displayed in this slot.

MODE 1	Indicates that the entire loop is capable and ready for coupling for dual axes ACL control.
MODE 2	Indicates that the entire loop is not capable of Mode 1 coupled approach but is capable of Mode 2 manual control approach using uplinked situation steering.
T/C	Traffic control cue indicates that the entire loop is capable and ready for couple to the T/C heading command.
TILT	Indicates that the uplinked information is not being updated. When this condition exists all uplinked information is removed from the displays and the FCS is uncoupled from the data link commands.

c. The following uplinked group 2c discretes may be displayed in this slot. These cues are displayed for 30 seconds after initial receipt, then removed.

10 SEC	Indicates that SPN–42 is now adding deck motion compensation to the longitudinal and lateral axes commands. This discrete is received approximately 12.5 seconds before touchdown.
ADJ A/C	Adjacent aircraft cue indicates that another aircraft has been detected in the area of controlled aircraft.
VOICE	Indicates that the pilot is to establish voice contact with control.

d. The following onboard capability cues are displayed in this slot.

ACL 1	Indicates that onboard systems are capable of an ACL or T/C couple to the FCS.
ACL 2	Indicates that onboard systems are not capable of ACL or T/C couple to FCS, but are capable of displaying uplinked information for a mode 2 manual approach.
ACL N/A	Indicates that onboard systems are not capable of using uplinked information and that a carrier controlled approach (CCA) must be made.
TEST	Indicates that ACL mode is in test.

e. The UTM FAIL cue is displayed in this slot when valid uplinked UTM 3A and UTM B were not received during automatic test.

f. Command heading is displayed via the double chevron symbol on the outside of the compass rose.

g. Command airspeed is displayed in this slot.

h. Command altitude is displayed on this slot.

i. Command rate of descent is displayed in this slot.

j. The compass rose is track–up oriented with selectable ranges of 10, 20, 40, 80, 160, and 320 NM.

HUD ACL Display

Figure 7–17 shows the possible HUD display information. The lettered symbols and cues on the HUD are described after the corresponding letter in the following paragraphs.

a. Uplinked command heading is indicated by the command heading steering pointer below the heading scale.

b. The following cues may be displayed in this slot.

10 SEC	Displayed for 30 seconds after receipt and then removed. Also displayed on link 4 display.
TILT	Displayed when communication has been lost with data link control. Also displayed on link 4 display.
DATA	Displayed for 10 seconds and flashed at a rate of two times per second when new data is initially displayed on the link 4 display.

c. The following cues may be displayed in this slot.

ACL RDY	Displayed when received via data link and the FCS is not coupled. Also displayed on link 4 display.

HUD ACL Display

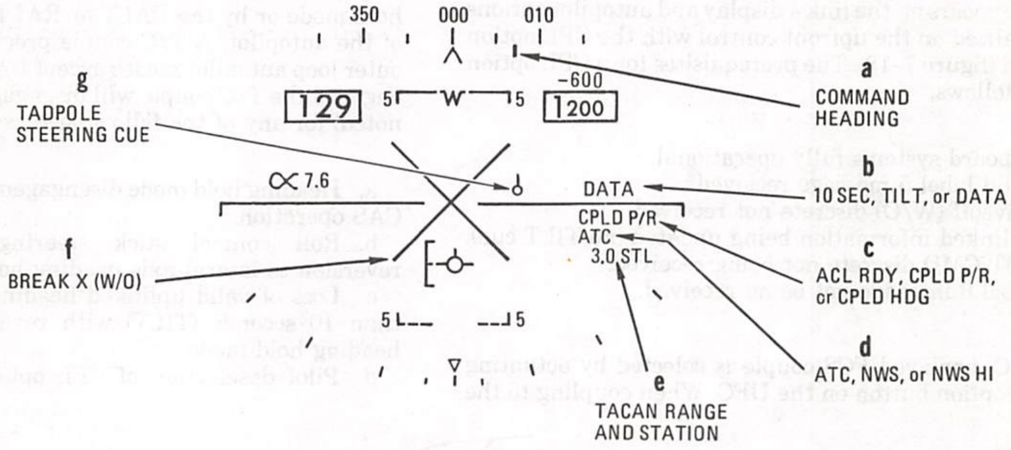

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Figure 7-17. HUD ACL Display

CPLD P/R	Coupled in pitch and roll is displayed when the FCS is coupled to the longitudinal and lateral commands. The cue is flashed for 10 seconds at two times per second then removed if the couple attempt is unsuccessful, or if uncouple occurs for any reason other than pilot deselection. Disengagement, other than pilot initiated, will also result in an AUTOPILOT caution.
CPLD HDG	Coupled to heading commands cue is displayed when FCS is coupled in the T/C mode. This cue is flashed for the same reasons as described for the CPLD P/R cue.

d. The following cues may be displayed in this slot. These cues are mode independent and may be displayed in any master mode.

ATC	Displayed when automatic throttle control is engaged. If an unsuccessful engagement attempt occurs, or if the ATC disengages for any reason other than pilot deselection, the ATC cue to flashed for 10 seconds at two times per second, then removed.
NWS	Indicates low gain nosewheel steering is engaged.
NWS HI	Indicates high gain nosewheel steering is engaged.

e. When ACL mode is initially selected, waypoint steering is automatically deselected, if selected, and the system is automatically undesignated if an aimpoint is designated. If tacan is on, tacan range is automatically displayed regardless of tacan steering selection unless the pilot subsequently designates an aimpoint or selects waypoint steering.

f. When the W/O discrete is initially received, the break X is displayed for 10 seconds flashing at two times per second, then it is removed.

g. The tadpole steering symbol is referenced to the velocity vector and provides uplinked flight path steering indications for the ACL glide slope and course.

ACL MODE OPERATION

Initialization

The data link ACL mode is selected by actuating the ACL option button on the HI. When selected, the ACL legend on the HI is boxed and the link 4 display is automatically selected on the left DDI. The TEST cue is displayed indicating the ACL mode is in test. The ILS, data link, and radar beacon are automatically turned on (if not previously on); IBIT is run on the data link and radar beacon systems. Also the uplinked UTM is monitored for valid receipt. When ACL testing is complete the TEST cue is removed, the noted systems are placed in the correct operational mode, the stored data link ACL frequency is automaticlly selected, and the pilot is cued on the link 4 display relative to onboard ACL capability (ACL 1, ACL 2, or ACL N/A) as previously described. If during test, a valid uplinked UTM message was not received, the UTM FAIL cue is displayed on the link 4 display.

Traffic Control Couple

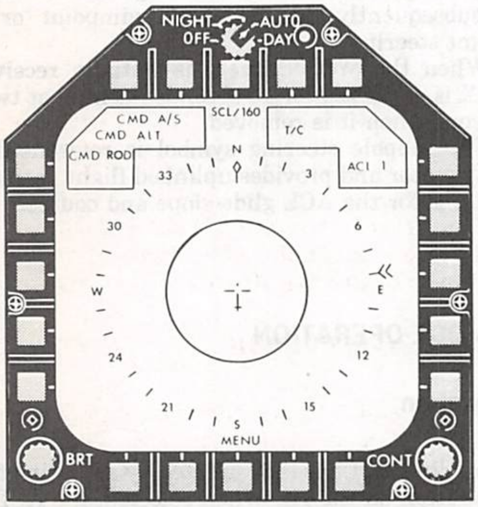
When an uplinked label 5 message is received, a determination is automatically made relative to total loop capability. If the ACL loop is ready for a T/C couple, the T/C cue appears on the link 4 display and autopilot options are initialized on the upfront control with the CPL option displayed (figure 7-18). The prerequisites for a CPL option for T/C follows:

a. Onboard systems fully operational.
b. Valid label 5 message received.
c. Waveoff (W/O) discrete not received.
d. Uplinked information being updated (no TILT cue).
e. NOT CMD discrete not being received.
f. Label 6 message not being received.

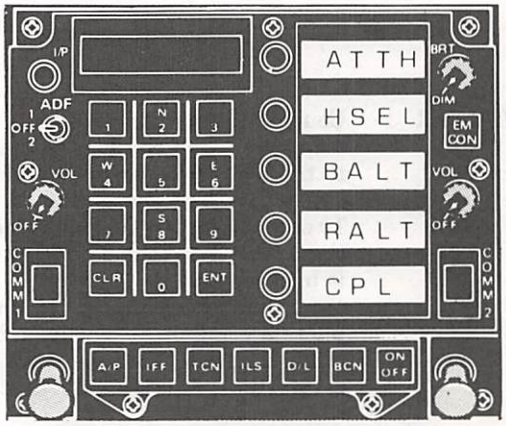
With T/C displayed FCS couple is selected by actuating the CPL option button on the UFC. When coupling to the T/C heading command is successful a colon is displayed in front of the CPL option on the UFC and the CPLD HDG cue is displayed on the HUD. After couple the FCS will bank the aircraft to maximum of 30° to capture and hold the uplinked heading command. Aircraft pitch attitude may be controlled by the pitch hold function of the heading hold mode or by the BALT or RALT altitude hold modes of the autopilot. A T/C couple precludes use of all other outer loop autopilot modes except BALT and RALT. When engaged the T/C couple will disengage (with reversions as noted) for any of the following reasons.

a. Heading hold mode disengagement with reversion to CAS operation.
b. Roll control stick steering engagement with reversion to lateral axis heading hold mode.
c. Loss of valid uplinked heading command for more than 10 seconds (TILT) with reversion to lateral axis heading hold mode.
d. Pilot deselection of CPL option with reversion to

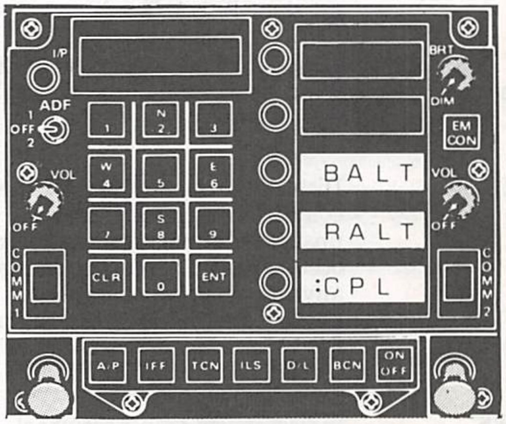
Traffic Control Couple Displays



LINK 4 DISPLAY



UFC AUTOPILOT OPTIONS (HEADING HOLD ENGAGED)



UFC AUTOPILOT OPTIONS (T/C MODE ENGAGED)

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Figure 7-18. Traffic Control Couple Displays

lateral axis heading hold mode.

e. Pilot actuation of paddle switch with reversion to CAS.

f. Receipt of uplinked W/O discrete with reversion to lateral axis heading hold mode.

g. Receipt of uplinked NOT CMD discrete with reversion to lateral axis heading hold mode.

An unsuccessful T/C couple attempt, or disengagement of the T/C couple for any reason other than pilot deselection, will result in an AUTOPILOT caution as well as the CPLD HDG on the HUD flashing for 10 seconds.

ACL Mode 1

When an uplinked label 6 message is received, a determination is made with respect to total loop capability relative to dual-axis (lateral and longitudinal) ACL couple. If ACL couple is determined to be available, the MODE 1 cue is displayed on the link 4 display and the autopilot options are initialized on the UFC with CPL option displayed as shown in figure 7-19.

When the pilot selects the CPL option on the UFC, an ACL couple to the FCS is requested if proper prerequisities are met.

NOTE

> If FCS is already coupled to T/C command heading, the first actuation of the CPL option disengages T/C couple and a second actuation requests ACL couple.

The MC prerequisities for initial ACL couple are as follows:

a. Basic FCS outer loop (heading hold) engaged. If heading hold is not engaged when the CPL option is actuated it is automatically requested, and when FCS indicates it is engaged, ACL couple is requested.

b. Onboard test results indicate ACL 1 capability.

c. Uplinked ACL RDY discrete being received. ACL RDY is only required for initial couple. It is not required after ACL couple occurs.

d. Uplinked A/P bit set to couple state.

e. Valid uplinked longitudinal and lateral axes commands being received (no TILT).

To indicate FCS is coupled, a colon is displayed next to CPL option on the UFC and the CPLD P/R cue is displayed on the HUD. When ACL couple initially occurs, the FCS fades in the longitudinal and lateral uplinked commands to minimize engagement transients. After FCS is coupled to the dual-axis commands, the FCS limits the accepted magnitude of the uplinked commands to prevent excessive pitch or roll changes due to large and/or erroneous uplinked commands. When FCS is coupled to ACL, uncouple will occur, with reversion as noted, for any of the following reasons.

a. Heading hold mode disengagement with reversion to CAS operation.

b. Pitch or roll control stick steering engagement with reversion to heading hold when CSS is no longer engaged.

c. Weight on wheels with reversion to CAS.

d. Paddle switch actuation with reversion to CAS.

e. UFC CPL option actuation with reversion to heading hold.

f. Receipt of W/O discrete with reversion to heading hold.

g. Receipt of command degrading approach to mode 2 state with reversion to heading hold.

h. Loss of valid uplinked commands for more than 2 seconds (TILT) with reversion to heading hold.

i. Detection of degraded onboard capability below that required for MODE 1 with reversion to heading hold.

During an ACL coupled approach the D/L situation steering and the ILS situation steering may remain selected for HUD display to allow the pilot to monitor the progress of the automatic control in capturing and holding the desired glide slope and azimuth.

ACL Mode 1A

For an ACL mode 1A approach, the aircraft may be coupled to data link commands as described in the Mode 1 paragraph, then uncoupled at minimums (200 feet and 0.5 mile) and manual control as described for Mode 2 used the rest of the way to touchdown.

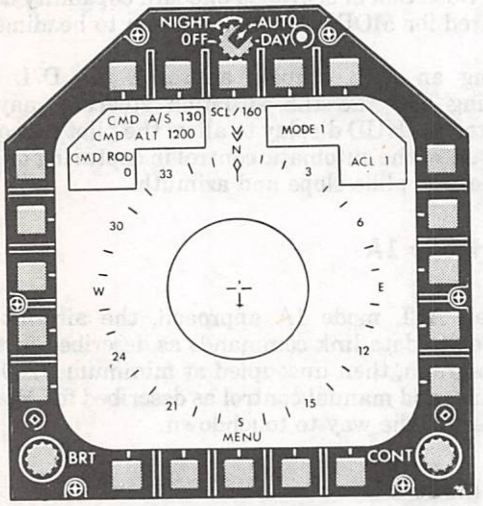
ACL Mode 2

When a label 6 message is initially received and a mode 1 or mode 2 capability exists, a mode 2 manual approach may be made. The data link HUD steering which may be manually selected with the D/L option button on the HI is automatically selected. The D/L legend on the HI is boxed and the data link situation steering tadpole is displayed on the HUD with the tadpole referenced to the velocity vector as shown in figure 7-20. The ILS situation display may remain selected on the HUD for cross check on the D/L situation display and/or either D/L or ILS display may be deselected by actuating the option button on the HI. Mode 2 approaches may be made with or without ATC engaged, but if available, ATC should be used for angle of attack/airspeed control. If ATC is not engaged the HUD angle of attack bracket should be used to control AOA/airspeed, while the glide slope is maintained by flying the D/L situation steering display on the HUD.

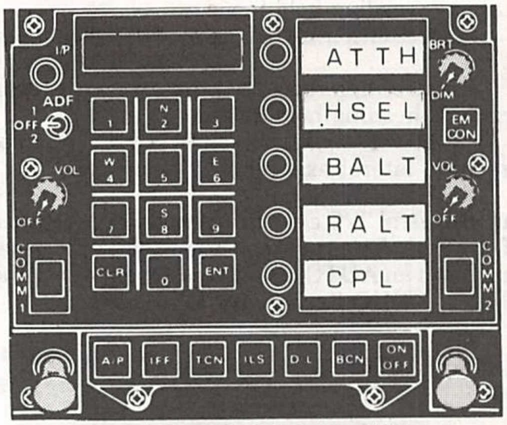
TYPICAL ACL APPROACH

Figures 7-21 and 7-22 describe the controls and displays for a "canned" mode 1 ACL approach. The ACL mode is optimized for the described approach, but abbreviated approaches and/or deviations as required may be used, dependent upon existing operational procedures and subsequent collaboration between the pilot and carrier control. Figure 7-21 shows a plan view of the approach with controls and displays for selected points prior to marshal. Figure 7-22 shows descent from marshal to touchdown. The depicted scenario uses only D/L steering and commands complemented with ILS steering in order to more clearly define D/L capability. It does not show TCN or WYPT steering which may be used in conjunction with, or independent of, D/L steering during the approach.

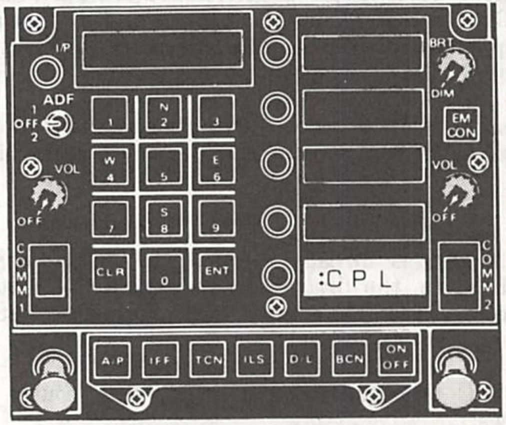
ACL Mode 1 Displays



LINK 4 DISPLAY



UFC AUTOPILOT OPTIONS
(HH MODE ENGAGED)
WITH CPL OPTION, TC OR ACL MODE AVAILABLE



UFC AUTOPILOT OPTIONS
(ACL COUPLED)

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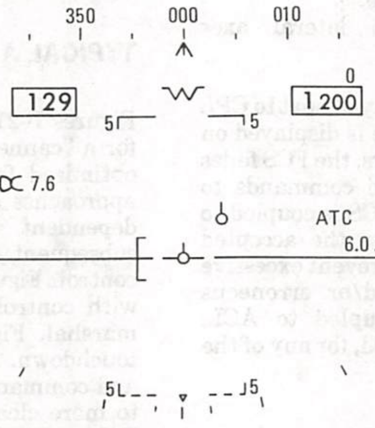
Figure 7-19. ACL Mode 1 Displays

ACL Mode 2 Steering Display



HUD DATA LINK
SITUATION STEERING SELECTED

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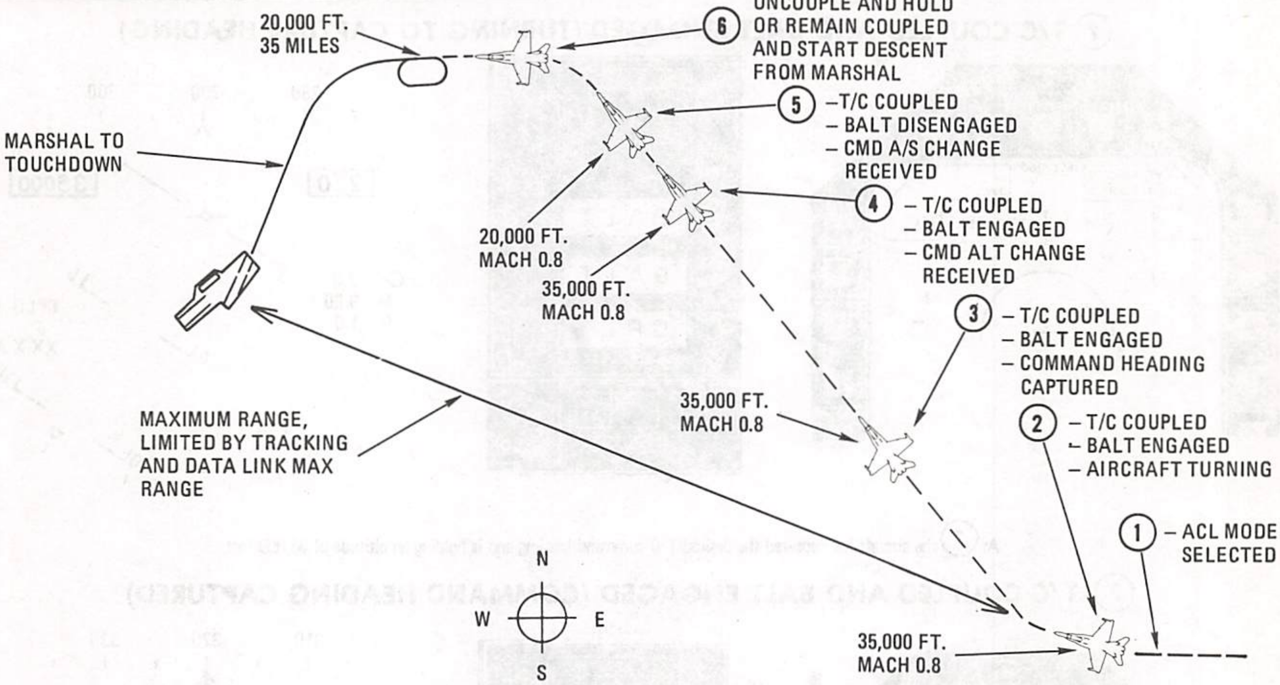
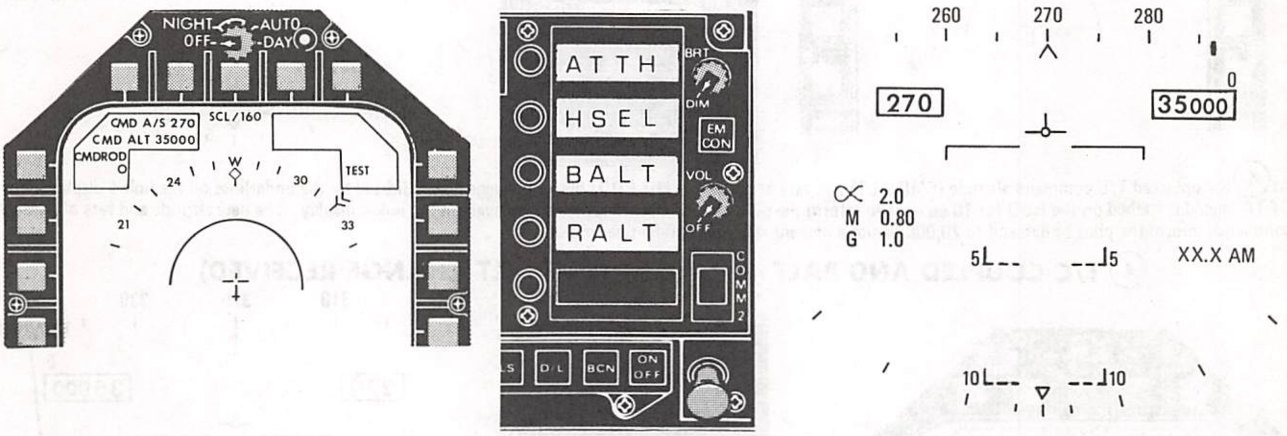
Figure 7–20. ACL Mode 2 Steering Display

T/C Guidance To Marshal



At ① the pilot has selected ACL mode on the HI and the onboard system is in test, as noted on the link 4 display. The HH mode has been engaged as shown by the other autopilot options being displayed on the UFC. D/L command information may be shown on the link 4 display and the HUD during test.

① ACL MODE SELECTED (SYSTEM IN TEST)



At ② the test is complete and the link 4 display shows ACL 1 onboard capability as well as total loop T/C capability. The pilot has coupled to the uplinked T/C command heading and has engaged the BALT altitude hold mode. The aircraft is banking to capture the uplinked command.

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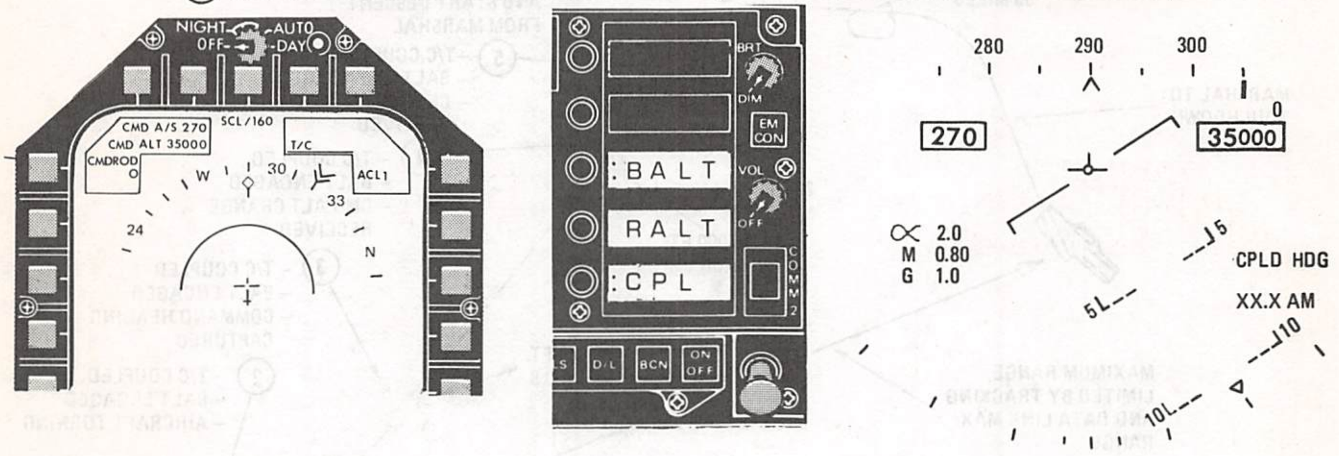
Figure 7-21. T/C Guidance to Marshal (Sheet 1 of 3)

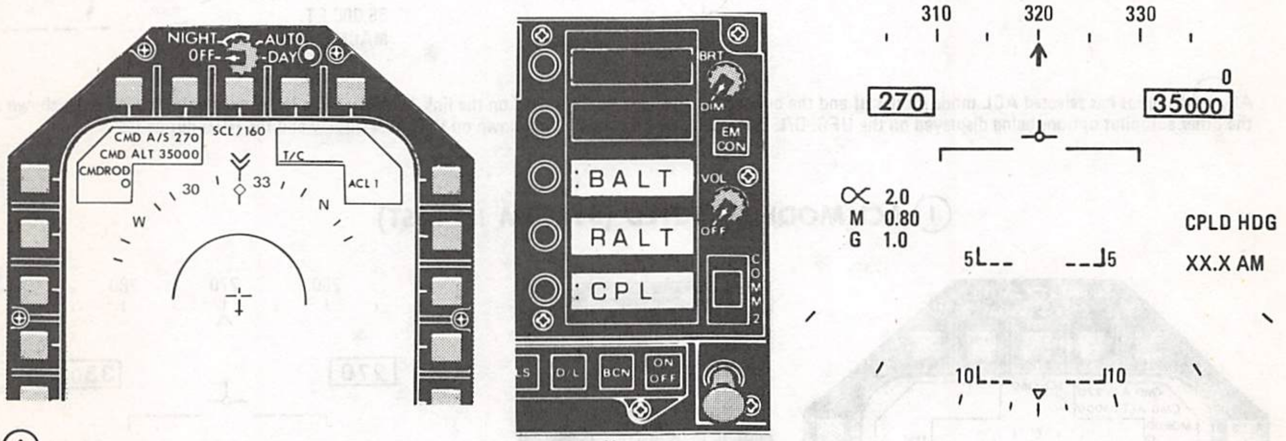
T/C Guidance To Marshal

② T/C COUPLED AND BALT ENGAGED (TURNING TO CAPTURE HEADING)



At ③ the aircraft has captured the desired T/C command heading and is holding an altitude of 35,000 feet.

③ T/C COUPLED AND BALT ENGAGED (COMMAND HEADING CAPTURED)



At ④ the uplinked T/C command altitude (CMD ALT) and rate of descent (CMD ROD) has just changed, as indicated by the underlines on the link 4 display. The DATA legend is flashed on the HUD for 10 seconds to inform the pilot that new information is displayed on the link 4 display. The new altitude and rate of descent commands inform the pilot to descend to 20,000 feet at a descent rate of 4,000 feet per minute.

④ T/C COUPLED AND BALT ENGAGED (CMD ALT CHANGE RECEIVED)

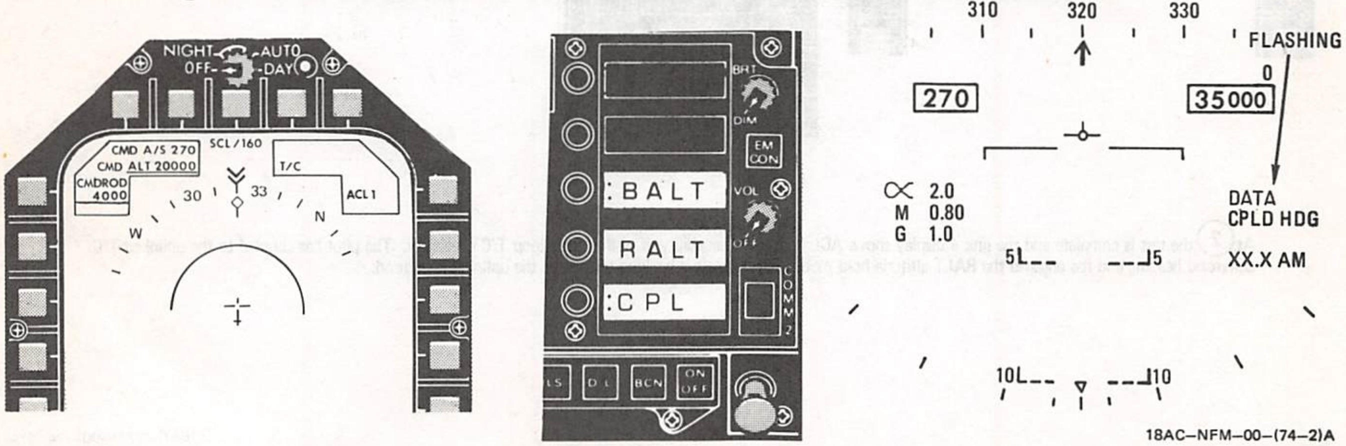


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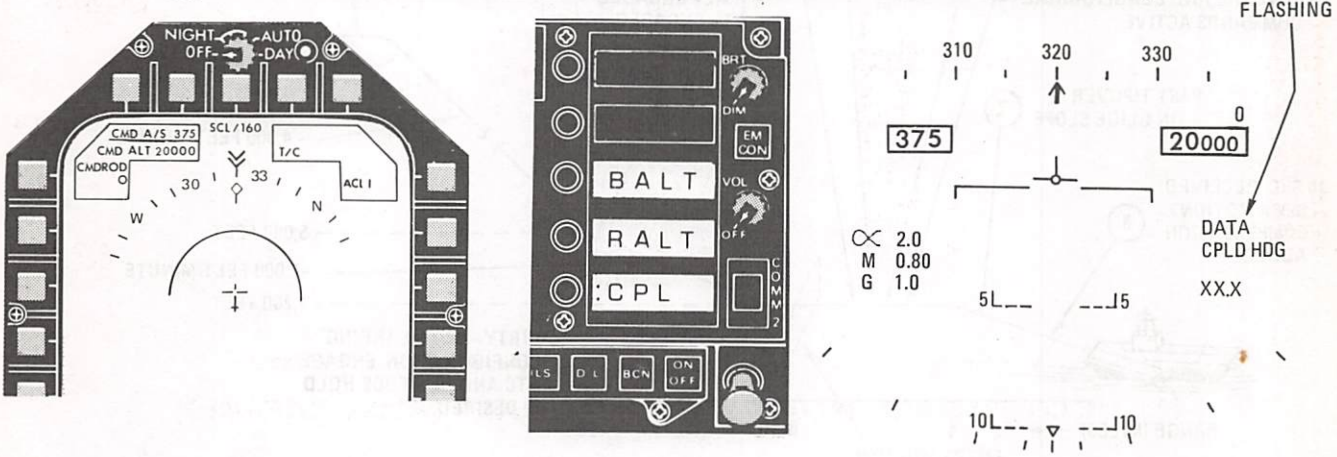
Figure 7-21. T/C Guidance to Marshal (Sheet 2)

T/C Guidance To Marshal

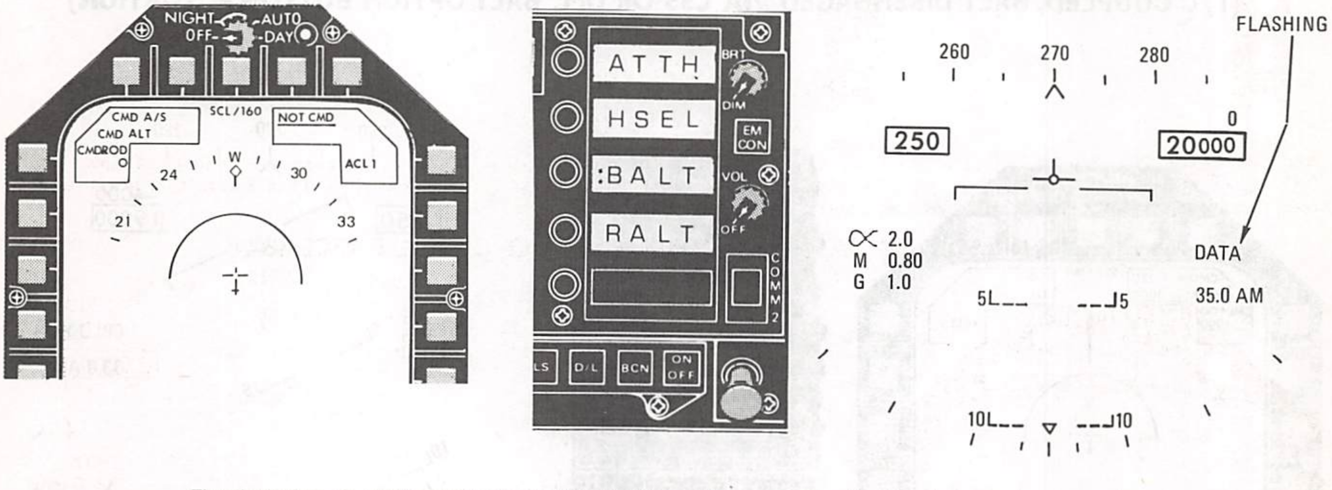
At ⑤ the pilot has leveled off at the new altitude. A new uplinked command airspeed has also been received and the pilot has established the new airspeed which maintains 0.8 Mach at 20,000 feet as commanded. With the new altitude established, the pilot may reengage BALT hold.

⑤ T/C COUPLED AND BALT DISENGAGED (CMD A/S CHANGE RECEIVED)



At ⑥ the aircraft is set up to hold in the marshal pattern at 20,000 feet. The uplinked D/L commands have been removed from the displays due to receipt of the uplinked NOT CMD. The carrier does not attempt to issue data link commands while the aircraft is holding in marshal since the uplinked command mechanization is not structured to provide aid during holding.

⑥ BALT ENGAGED - T/C UNCOUPLED (HOLDING IN MARSHAL PATTERN)



The pilot is given, via carrier control, a marshal departure time and a tacan range and bearing window for departure at the designated time. Once on the outbound leg for marshal departure, the uplinked D/L command information (command heading, altitude, rate of descent and airspeed) may be uplinked and displayed.

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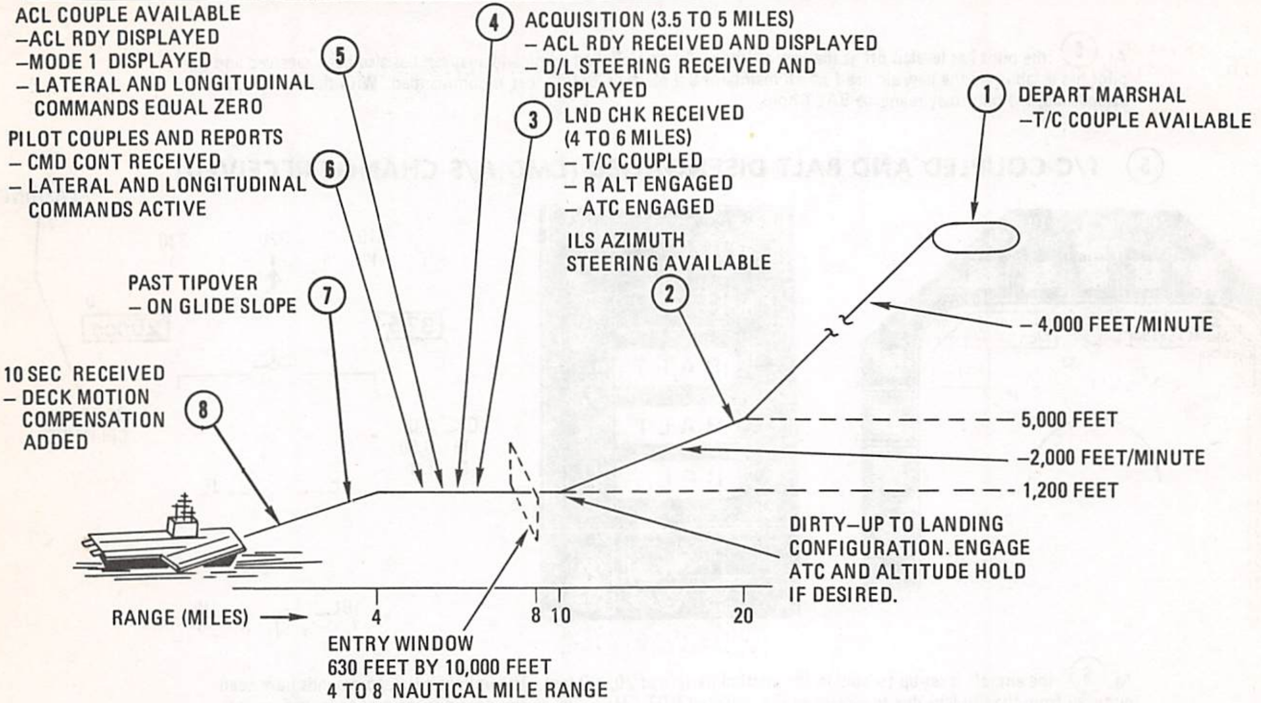
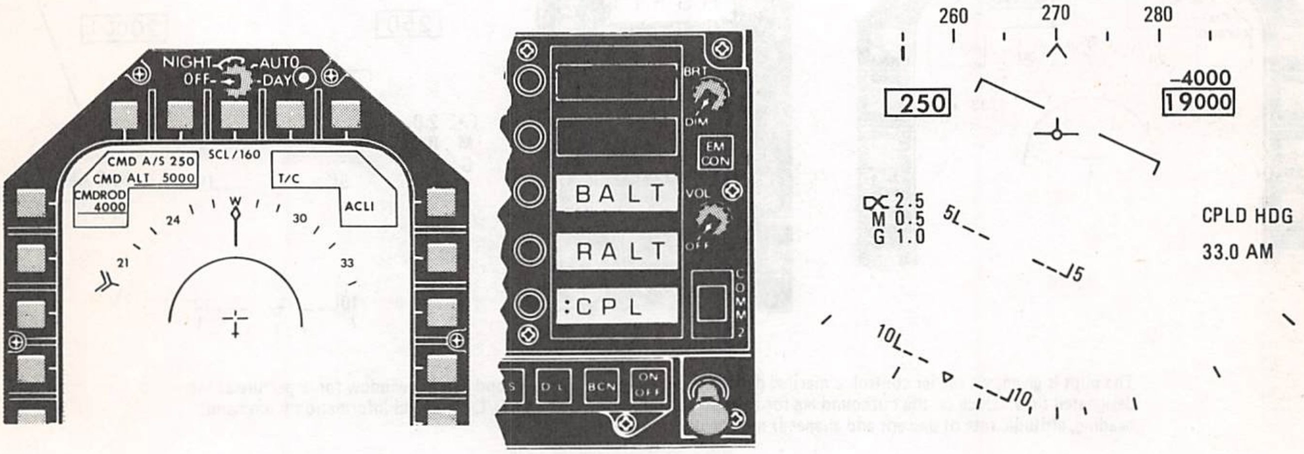
Figure 7-21. T/C Guidance to Marshal (Sheet 3)

ACL Control – Marshal To Touchdown


ACL COUPLE AVAILABLE
–ACL RDY DISPLAYED
–MODE 1 DISPLAYED
– LATERAL AND LONGITUDINAL COMMANDS EQUAL ZERO
PILOT COUPLES AND REPORTS
– CMD CONT RECEIVED
– LATERAL AND LONGITUDINAL COMMANDS ACTIVE
④ ACQUISITION (3.5 TO 5 MILES)
– ACL RDY RECEIVED AND DISPLAYED
– D/L STEERING RECEIVED AND DISPLAYED
⑤
⑥
③ LND CHK RECEIVED (4 TO 6 MILES)
– T/C COUPLED
– R ALT ENGAGED
– ATC ENGAGED
ILS AZIMUTH STEERING AVAILABLE
②
① DEPART MARSHAL
–T/C COUPLE AVAILABLE
PAST TIPOVER
– ON GLIDE SLOPE ⑦
– 4,000 FEET/MINUTE
10 SEC RECEIVED
– DECK MOTION COMPENSATION ADDED ⑧
5,000 FEET
–2,000 FEET/MINUTE
1,200 FEET
DIRTY–UP TO LANDING CONFIGURATION. ENGAGE ATC AND ALTITUDE HOLD IF DESIRED.
RANGE (MILES)
4
8
10
20
ENTRY WINDOW
630 FEET BY 10,000 FEET
4 TO 8 NAUTICAL MILE RANGE

At ① the pilot started the descent to platform. The aircraft has again been coupled to unlinked T/C command heading and is banking to capture this heading. The pilot has established the desired airspeed and descent rate as commanded via uplinked commands shown on the link 4 display. The desired result of following these commands will be to arrive on platform at a 5,000–foot altitude and 20 nautical mile range, then to shallow the descent rate to 2,000 feet per minute.

① DEPARTING MARSHAL (T/C COUPLED, BALT DISENGAGED VIA CSS OR UFC BALT OPTION BUTTON ACTUATION)



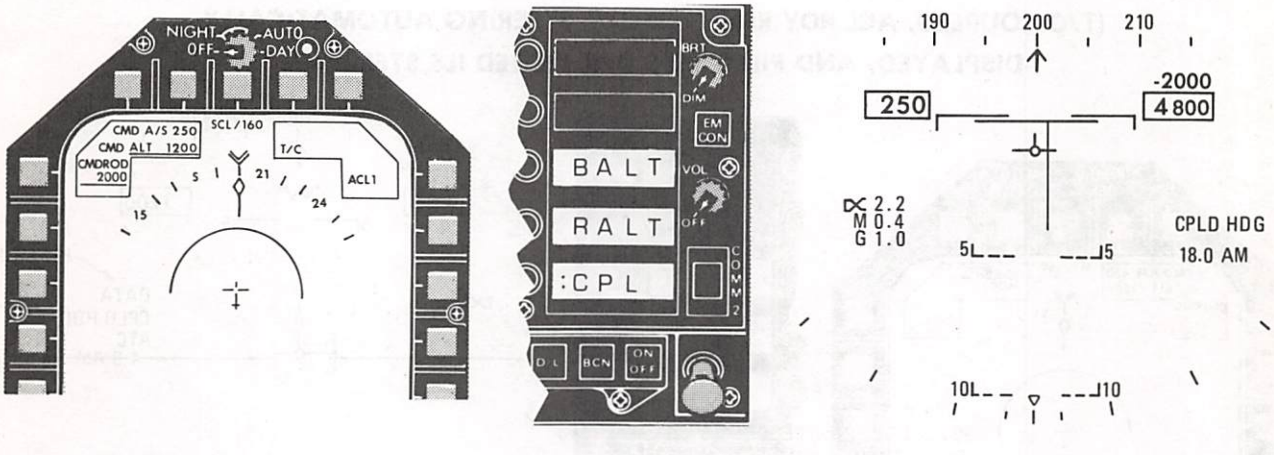
18AC–NFM–00–(81–1)A

Figure 7–22. ACL Control – Marshal to Touchdown (Sheet 1 of 5)

ACL Control–Marshal To Touchdown

At ② the aircraft is on platform with a descent rate of 2,000 feet per minute intended to arrive at a 1200–foot altitude at approximately 10 nautical miles. Valid ILS situation steering is available and has automatically been selected for HUD display when initially received. (The pilot may deselect the ILS steering via the HI ILS steering select button when desired.) The pilot may utilize the ILS azimuth deviation to manually capture and/or maintain the desired azimuth alignment for approach, but the glide slope ILS deviation bar should not be used until tipover, since it will be indicating fly–up.

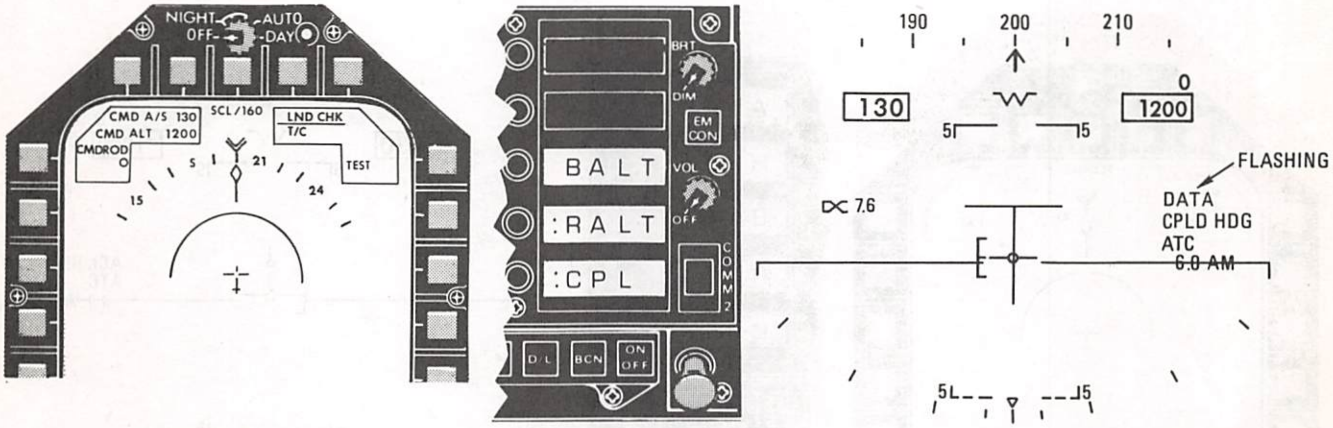
② ILS AZIMUTH STEERING VALID



At ③ the aircraft has leveled at 1,200 feet, in the landing configuration, with auto throttle control engaged, as indicated by the ATC cue on the HUD. The underlined legend on the link 4 display shows that the uplinked LND CHK discrete has been received. This cue indicates that positive SPN–42 communication has been established as well as cuing the pilot that the aircraft should be in the landing configuration and at the approach speed. From this point in the approach, the HUD velocity vector should be caged to enhance and/or optimize the angle of attack bracket and situation steering displays on the HUD.

③ LND CHK DISCRETE RECEIVED

(LANDING CONFIGURATION WITH T/C COUPLED, RALT AND ATC ENGAGED)



18AC–NFM–00–(81–2)

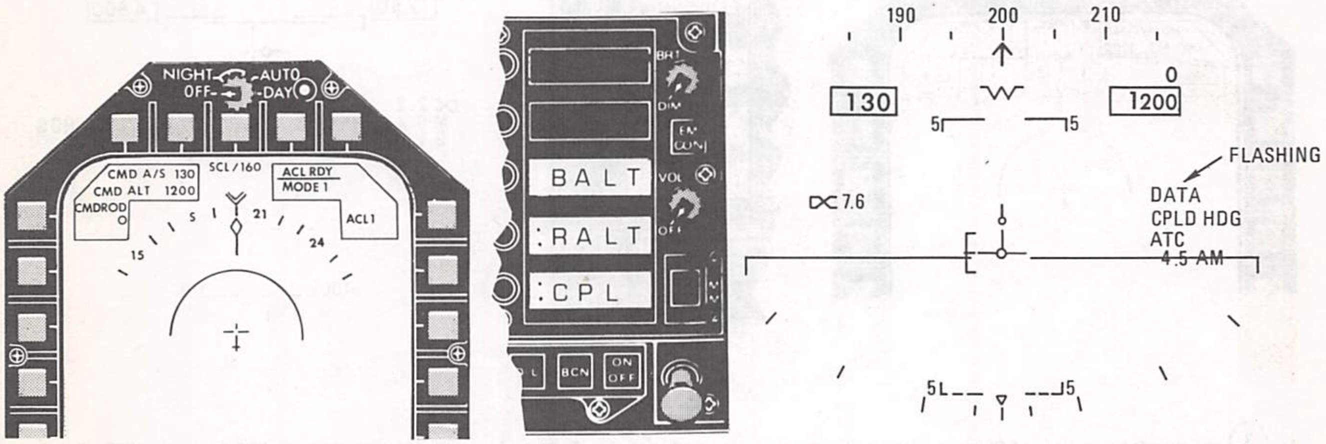
Figure 7–22. ACL Control – Marshal to Touchdown (Sheet 2)

ACL Control—Marshal To Touchdown

At ④ the pilot has engaged radar altitude hold (RALT) at 1,200 feet. The uplinked ACL RDY legend indicates that the SPN–42 has acquired the aircraft and is now uplinking longitudinal and lateral commands to the aircraft equal to 0 feet per second and 0° roll attitude. The MODE 1 legend indicates that the total loop is capable of, and/or ready for, a dual–axis couple of the uplinked commands to the FCS. The FCS is still coupled to the uplinked head command as indicated by the CPLD HDG legend displayed on the HUD. Also available is the uplinked D/L situation steering shown via the tadpole displayed on the HUD. The pilot has deselected the ILS steering, but may select or deselect either or both ILS and D/L situation steering to monitor coupled control progress.

④ACQUISITION

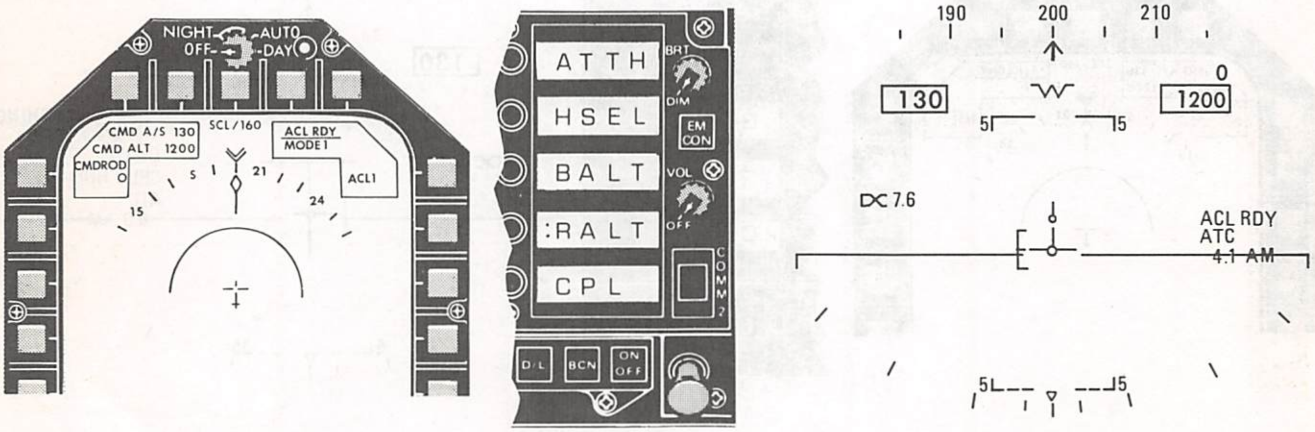
(T/C COUPLED, ACL RDY RECEIVED, D/L STEERING AUTOMATICALLY DISPLAYED, AND PILOT HAS DESELECTED ILS STEERING)



At ⑤ the pilot has uncoupled from the uplinked T/C command heading by deselection of the CPL option on the UFC. When the aircraft is not coupled, the ACL RDY legend is displayed on the HUD. To couple the aircraft to the dual–axis uplinked longitudinal and lateral commands requires that the pilot again select the CPL option on the UFC.

⑤ACL COUPLE AVAILABLE

(T/C UNCOUPLED BY PILOT)



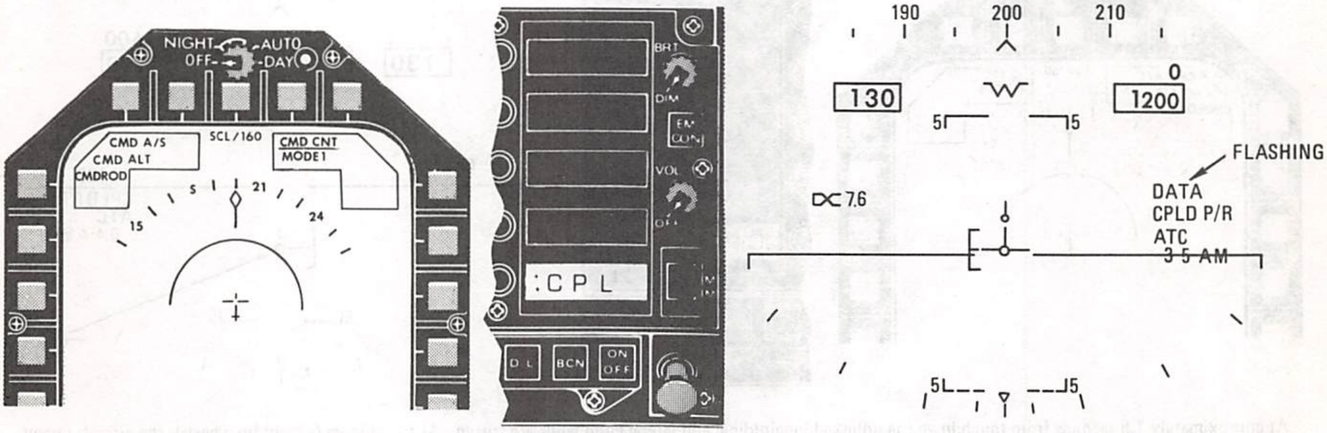
18AC–NFM–00–(81–3)

Figure 7–22. ACL Control – Marshal to Touchdown (Sheet 3)

ACL Control—Marshal To Touchdown

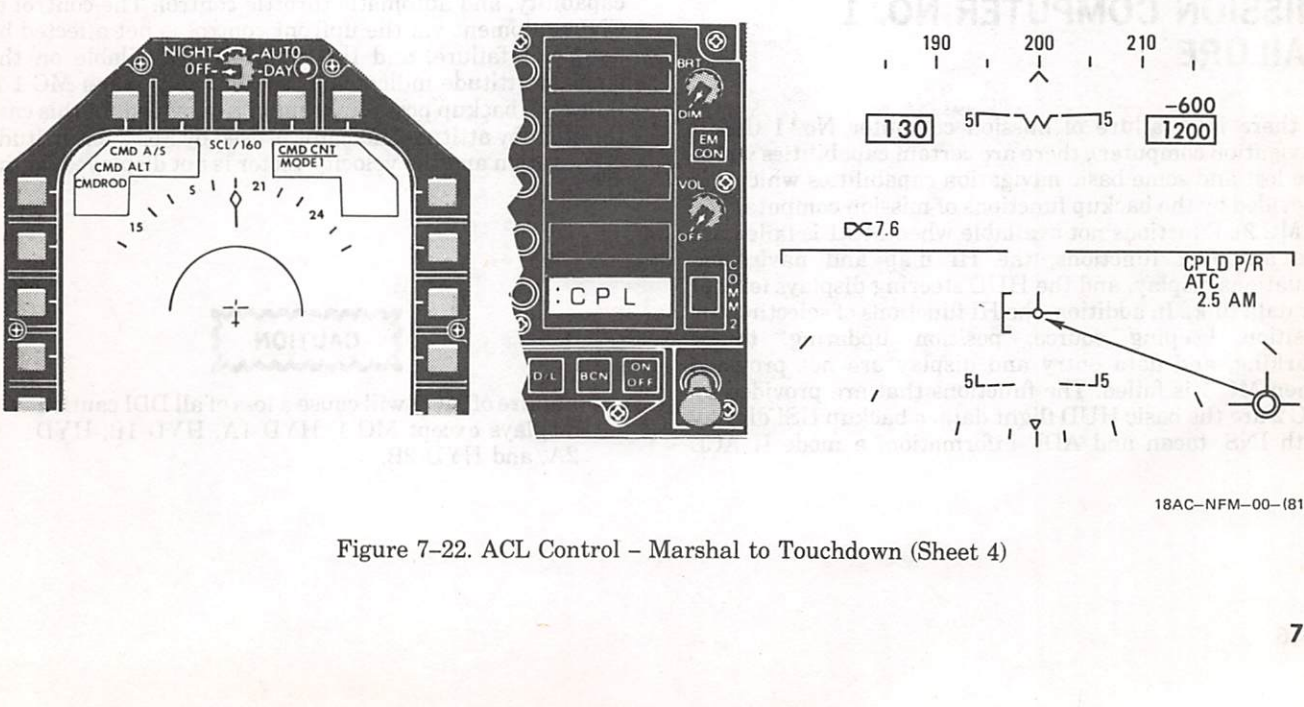
At ⑥ the aircraft is now coupled to the uplinked dual–axis commands as indicated by the CPLD P/R legend displayed on the HUD. The pilot has reported couple to the carrier control via voice communication and subsequently the aircraft has received the uplinked CMD CNTR discrete indicating that the uplinked longitudinal and lateral commands are active. The uplinked commands of heading, airspeed, altitude, and rate of descent are removed from the link 4 and HUD displays by the MC when the aircraft is coupled to the dual–axis commands as these commands are no longer updated by the carrier. The pilot will be advised via voice communication as he approaches tipover, but no aircraft control action is required on his part. (At least 30 seconds of coupled control is desirable prior to tipover.)

⑥ ACL MODE COUPLED BY PILOT
(CMD CNT RECEIVED)



At ⑦ the aircraft is past tipover on the desired glide slope and azimuth as indicated by the alignment of the D/L tadpole inside the velocity vector on the HUD.

⑦ PAST TIPOVER
(ACL MODE COUPLED, ON GLIDE SLOPE)



18AC–NFM–00–(81–4)

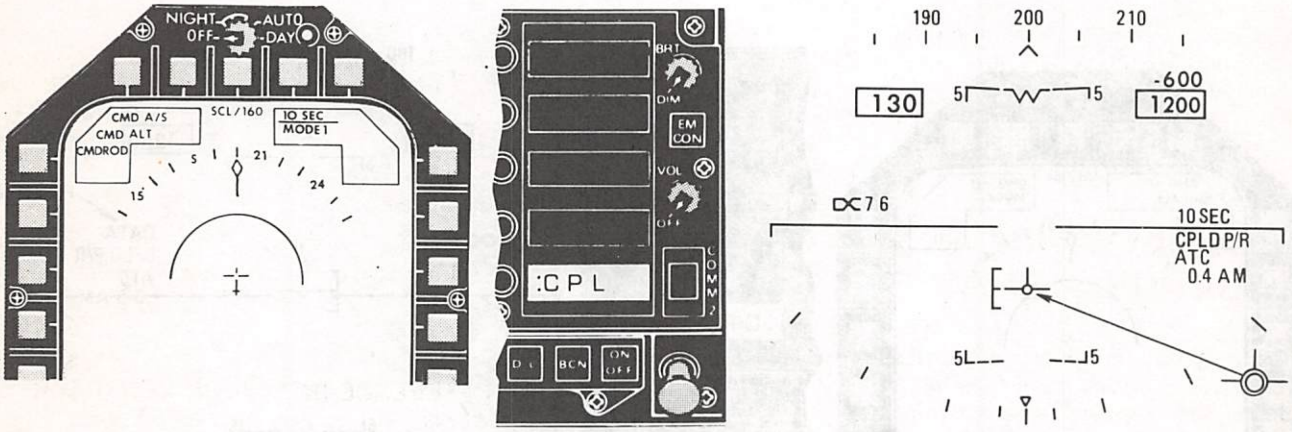
Figure 7-22. ACL Control – Marshal to Touchdown (Sheet 4)

ACL Control—Marshal To Touchdown

At ⑧ approximately 12.5 seconds prior to touchdown, the uplinked 10 SEC discrete is received and displayed on both the HUD and the link 4 displays. Receipt of the 10 SEC discrete indicates that deck motion compensation is now being added to the uplinked longitudinal and lateral commands.

⑧ 10 SEC DISCRETE RECEIVED

(ACL COUPLED, ON GLIDE SLOPE)



At approximately 1.5 seconds from touchdown the uplinked longitudinal and lateral commands are frozen. At touchdown (weight on wheels), the aircraft uncouples from the uplinked commands.

18AC–NFM–00–(81–5)B

Figure 7-22. ACL Control — Marshal to Touchdown (Sheet 5)

BACKUP/DEGRADED OPERATIONS

MISSION COMPUTER NO. 1 FAILURE

If there is a failure of mission computer No. 1 (MC 1 navigation computer), there are certain capabilities which are lost and some basic navigation capabilities which are provided by the backup functions of mission computer No. 2 (MC 2). Functions not available when MC 1 is failed are the autopilot functions, the HI map and navigation situations display, and the HUD steering displays (except for data link). In addition, the HI functions of selecting the position keeping source, position updating, target marking, and data entry and display are not provided when MC 1 is failed. The functions that are provided by MC 2 are the basic HUD flight data, a backup HSI display with INS, tacan and ADF information, a mode II ACL capability, and automatic throttle control. The control of CNI equipment via the upfront control is not affected by an MC 1 failure, and ILS steering is available on the standby attitude indicator. If the INS fails when MC 1 is failed, no backup position keeping is provided. In this case the standby attitude indicator is used by MC 2 for attitude information and the velocity vector is not displayed on the HUD.

CAUTION

Failure of MC 1 will cause a loss of all DDI caution displays except MC 1, HYD 1A, HYD 1B, HYD 2A, and HYD 2B.

Backup HUD Display

With MC 1 failed, the backup HUD display is identical with the primary HUD display, except that the bank angle scale is not provided and the heading scale is at the same positon as in the weapon delivery modes. The ghost velocity vector is provided during backup operation, and the velocity vector may be caged/uncaged.

Backup HSI Display

With MC 1 failed, the backup HSI display consists of a magnetic compass rose oriented heading–up with a tacan pointer and an ADF pointer. A digital readout of tacan bearing and distance and the station identifier are provided in the upper left corner. The INS present position is displayed inside the compass rose at the top center. The ACL mode option pushbutton is also displayed for selection if desired.

BACKUP ATTITUDE AND NAVIGATION SYSTEM

If a failure occurs in the primary attitude and navigation system (INS), output signals of pitch, roll, magnetic heading, and airspeed are provided to the mission computer system for use in the backup attitude navigation computations. The backup system consists of an attitude reference indicator, a static power inverter, and a magnetic azimuth detector.

ATTITUDE REFERENCE INDICATOR

The attitude reference indicator (figure 7–23) is a self–contained pitch and roll instrument on the main instrument panel. An electrically driven vertical gyro maintains vertical orientation by use of an electronic erection system. The erection system automatically cuts off when lateral accelerations exceed approximately 0.15G. The gyro spin speed and erection system provides a minimum of three minutes of attitude information with a total power loss. Pitch and roll servos provide back up pitch and roll attitude for use by other systems. The attitude presentation is 360° in roll, 92° in climb, and 78° in dive.

STATIC POWER INVERTER

If there is an interruption or loss of aircraft ac power, 28 volt dc power is applied to the static power inverter to produce the 115 volt ac power needed for attitude reference indicator operation.

MAGNETIC AZIMUTH DETECTOR

The magnetic azimuth detector (MAD) consists of 3 sensing elements configured in a wye. The sensing elements are mounted so that their average positions are maintained in the horizontal component of the earth's magnetic field. The air data computer processes the detected magnetic heading and develops the magnetic error compensation signals.

BACKUP ATTITUDE AND NAVIGATION SYSTEM CONTROLS AND INDICATORS

The controls and indicators for the backup system are on the horizontal indicator and the attitude reference indicator.

Horizontal Indicator

The HI provides horizontal situation and steering control displays.

ATTITUDE REFERENCE INDICATOR CONTROLS AND INDICATORS

The controls and indicators on the attitude reference indicator (figure 7–14) are described as follows:

a. Off flag. This flag is in view when power is removed or the pull to cage knob is pulled out.

b. Miniature aircraft. This represents the nose and wings of the aircraft and indicates pitch and roll attitude relative to the horizon. The miniature aircraft is adjustable through ±5° of pitch trim by rotating the pull to cage knob clockwise or counterclockwise when the knob is pushed in.

c. Pull to cage knob. When the knob is pulled out and held it orients the gyro spin axis to the ARI case (pitch position). When the knob is pulled out and rotated clockwise to engage detent the ARI becomes caged.

Attitude Reference Indicator

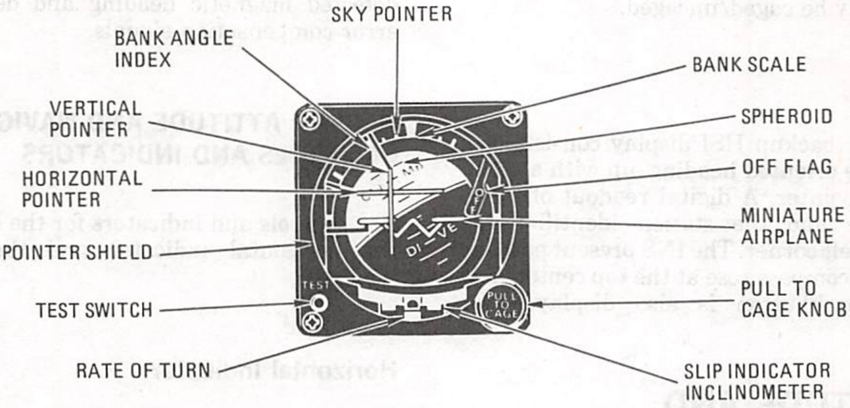


Figure 7–23 Attitude Reference Indicator

CAUTION

Do not lock the gyro in the caged position with the pull to cage knob if the gyro is spinning. Damage to the gyro might occur if the indicator or the aircraft is moved while the gyro is spinning and caged. If the knob is in the locked position, it must be pulled out to clear the detent before it can be turned counterclockwise.

d. Slip indicator (inclinometer). This mechanical indicator displays sideslip.

e. Rate of turn needle. This needle displays the rate of turn. One needle width of deflection indicates a 90° per minute rate of turn.

f. Test switch. The test switch is pressed and the vetical and horizontal pointers and rate of turn needle are watched for deflection.

g. Pointer shield. This shield conceals the vertical pointer when in the stowed position.

h. Horizontal pointer. The pointer provides direction information for pitch steering.

i. Bank scale. The scale rotates with the aircraft to provide measurement of angular displacement by the bank angle index during maneuvers.

j. Vertical pointer. The pointer provides direction information for azimuth steering.

k. Sky pointer. The pointer rotates with the aircraft to indicate vetical (sky) in any roll attitude.

l. Bank angle index. The index indicates vertical in any roll attitude.

m. Display sphere. The sphere is directly coupled to the gyro gimbals to provide a direct reading of pitch and roll. The sphere is marked at each 5° in pitch.

NAVIGATION CONTROLS AND INDICATORS

HI Display

The symbols and digital readouts that normally appear on the HI during backup system operation are the same as in the INS operation except for the POS OPTION DISPLAY description.

POS OPTION DISPLAY

Pressing the POS/ADC pushbutton on the HSI display commands the mission computer system to use air data computer true air speed, MAD heading, wind speed, and direction to compute aircraft latitude and longitude in waypoint steering computation.

BACKUP FREQUENCY CONTROL

Backup frequency control for the radios in case of an upfront control or communication system control (CSC) malfunction is provided via the multiplex bus and a DDI display. The upfront control backup (UFC BU) display can be selected from the Menu. Both COMM 1 and COMM 2 can be controlled from the UFC BU display. When the COM1 or COM2 button is pressed, the frequency on which that radio is operating is displayed below the legend COM1 or COM2, as appropriate. A new frequency is entered by using the numerical buttons along the sides of the display and ENT button at the bottom. As the new frequency is entered, it is displayed in the scratch pad above the COM1 or COM2 legend. When the ENT button is pressed, the frequency displayed in the scratch pad is stored in the mission computer as the preset frequency for the radio. However, the frequency of the radio is not changed at that time unless the OVRD option is selected. Pressing the CLR button clears the scratch pad if an error is made when entering a backup frequency. When OVRD option in the upper right corner of the display is selected, it is boxed and the radio operates on the preset frequency stored for it in the mission computer, overriding the normal frequency control from the UFC and CSC. When OVRD is deselected, frequency control reverts to the upfront control. The frequency displayed below the COM1 or COM2 legend is always the frequency on which the radio is operating, whether or not OVRD is selected. Upon power up with weight on wheels, the preset frequencies stored in the mission computer for COM1 and COM2 are initialized to be the same as the last valid radio operating frequencies.

NAVIGATION BACKUP

Position keeping for aircraft navigation requires available sources of heading information, attitude information and velocity. The INS normally provides position keeping for the aircraft. However, under various failure conditions, alternate sources of heading, attitude and/or velocity information may be used for position keeping. The backup heading modes are discussed in a following paragraph. The attitude reference indicator is the alternate source of attitude information. The alternate sources of velocity information are air data (true airspeed and angle of attack) or radar doppler velocities. Air data vertical velocity is an alternate velocity source if only the vertical component of INS velocity is invalid. The flight control set is an alternate source for angle of attack information.

The system automatically reverts to alternate data sources under failure conditions. For example, air data position keeping is autmatically selected in case of an INS failure. During air data position keeping, true airspeed and angle of attack from the air data computer and the last computed wind, or the wind inserted by the pilot via the upfront control, are used. The wind can also be updated during air data position keeping by performing a velocity update. A new wind is calculated when the velocity update is accepted. Another method of updating the wind during air data position keeping is to select in-flight alignment (IFA) on the INS switch. Then the wind is automatically updated during the 10 seconds of every minute that the radar is commanded to PVU mode. The velocity vector on the HUD is flashed at a slow rate (on for 0.8 seconds and off for 0.8 seconds) during air data position keeping.

The radar doppler velocities are automatically used by the mission computer if they are available and no other velocity sources are available (both INS and ADC failed). This applies whether or not tacan position keeping is selected. Doppler velocities are available when the radar is operating in a doppler beam sharpened (DBS) mode or PVU mode. Thus, the mission computer will automatically use the doppler velocities under these conditions if a DBS mode is selected, if velocity update is selected (without accepting or rejecting the update) or if IFA is selected with the INS switch. In the latter case, doppler velocities are available for 10 seconds of each minute.

BACKUP HEADING MODE CONTROL

If the INS computer should fail or if the INS switch is rotated to the GYRO position, the INS reverts to the attitude heading reference system (AHRS) mode and true heading is no longer available from the INS. In this case, the mission computer slaves the INS platform heading with the MAD to provide damped magnetic heading. The slaving of the INS platform to the MAD occurs in straight and level flight. During maneuvers, when roll is greater than ±5° or pitch is greater than ±10°, the MAD output is not used. Upon reversion to the Slaved heading mode, the bottom row of option selections on the HI are HDG/SLV, SYNC, and ERECT. The sync option can be used to quickly synchronize the heading with the MAD output if a heading error exists. The MC automatically synchronizes the heading with the MAD output when the heading error is greater than 11.25° during level flight. Pressing the ERECT option commands the INS to increase the gains in the INS erection loops, thus fast-leveling the platform. SYNC and ERECT are momentary options and they should be used only in straight and level flight.

If it is desired to change the backup heading mode, the heading status option pushbutton should be pressed (HDG/SLV in this case) and the available heading options (SLV, DG, and COMP) are presented on the HI. Selecting any of these three options commands the mission computer to display the selected option and necessary controls for that option. In the case of failure conditions, the next best available source is automatically selected.

Selection of the DG heading mode or failure of the MAD while in the HDG/SLV mode, causes the bottom pushbuttons on the HI to display HDG/DG, HDG (arrow left), HDG (arrow right), and ERECT. The mission computer computes aircraft heading using the INS platform heading as a smoothed heading source compensating for wander angle (the difference between true north and platform heading) and earth rate. The pilot may correct the aircraft heading by using the two HDG slew option buttons. Following the initial setting of the heading, the MC will provide heading compensation for earth rate. However, changes in magnetic variation must be entered via the upfront control since the aircraft will use the last known value of magnetic variation.

If the pilot selects the Compass heading mode, if the INS is turned off, or if the INS fails completely, the mission computer uses the MAD output, damped with body rate data from the flight control system. During maneuvers, when roll is greater than ±5° or pitch is greater than ±10°, the flight control system body rates, alone, are used to determine heading. In the compass heading (HDG/COMP) mode, the bottom buttons are labeled HDG/COMP and ERECT. The ERECT option is displayed only when the INS is still operating in the AHRS mode. The MC uses the last known magnetic variation to compute true heading.

Visual Communications

GENERAL SIGNALS

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Thumbs up, or nod of head	Flashlight moved vertically up-and-down repeatedly.	Affirmative. ("Yes," or, "I understand.")	
Thumbs down, or turn of head from side to side	Flashlight moved horizontally back-and-forth repeatedly	Negative. ("No," or, "I do not understand.")	
Hand cupped behind ear as if listening.		Question. Used in conjunction with another signal, this gesture indicates that the signal is interrogatory.	As appropriate
Hand held up, with palm outward.		Wait	
Hand waved back and forth in an erasing motion in front of face, with palm turned forward.	Letter N in code, given by external lights	Ignore my last signal.	
Employ fingers held vertically to indicate desired numerals 1 through 5. With fingers horizontal, indicate number which added to 5 gives desired number from 6 to 9. A clenched fist indicates 0. (Hold hand near canopy when signaling.)		Numerals as indicated.	A nod of the head ("I understand"). To verify numerals, addressee repeats. If originator nods, interpretation is correct. If originator repeats numerals, addressee should continue to verify them until they are understood.
Make hand into cupshape, then make repeated pouring motions.		I am going to dump fuel.	
Slashing motion of index finger across throat.		I have stopped dumping fuel.	

MALFUNCTIONING EQUIPMENT (HEFOE CODE)

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Weeping signal and then indicating by finger – numbers 1 to 5 the affected system.	Flashlight held close to top of canopy, pointed toward wingman, followed by 1 to 5 dashes to indicate system affected.	Number of fingers or dashes means: 1. Hydraulic/FCS 2. Electric 3. Fuel 4. Oxygen 5. Engine	Day: nod, or thumbs up ("I understand.") Night: Vertical movement of flashlight. Pass lead to disabled plane or assume lead, if indicated.

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Figure 7-24. Visual Communications (Sheet 1 of 5)

Visual Communications

TAKEOFF, CHANGING LEAD, LEAVING FORMATION, BREAKUP, LANDING

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
1. Section takeoff–leader gives thumbs up. 2. Wingman gives thumbs up. 3. Leader raises arm vertically 4. Leader lowers arm		1. I have completed my takeoff checklist and am ready for takeoff. 2. I have completed my takeoff checklist and am ready for takeoff. 3. Takeoff path is clear. 4. I am commencing takeoff.	1. Stands by for reply from wingman, holding thumbs up until answered. 2. Wingman stands by for immediate takeoff. 3. Execute section takeoff.
1. Leader pats self on the head, points to wing	1. Lead aircraft turns strobe lights ON. 2. If external lights are inoperative, leader shines flashlight on hard-hat, then shines light on wingman.	Leader shifting lead to wingman.	1. Wingman pats head and assumes lead 2. Wingman turns strobe lights OFF and assumes lead. If external lights are inop – 3. Wingman shines flashlight at leader, then on his hard hat and assumes lead.
Leader pats self on head and holds up two or more fingers.		Leader shifting lead to division designated by numerals.	Wingman relays signal; division leader designated assumes lead.
Pilot blows kiss to leader.		I am leaving formation	Leader nods ("I understand") or waves goodby.
Leader blows kiss and points to aircraft.		Aircraft pointed out leave formation.	Wingman indicated blows kiss and executes.
Leader points to wingman, then points to eye, then to vessel or object.		Directs plane to investigate object or vessel.	Wingman indicated blows kiss and executes.
Division leader holds up and rotates two fingers in horizontal circle, preparatory to breaking off.		Section break off.	Wingman relays signal to section leader. Section leader nods ("I understand") or waves goodby and executes.
Leader describes horizontal circle with forefinger.	Series of "I's" in code, given by external lights.	Breakup (and rendezvous).	Wingman take lead, pass signal after leader breaks, and follow.
Landing motion with open hand: 1. Followed by patting head. 2. Followed by pointing to another aircraft.		Refers to landing of aircraft, generally used in conjunction with another signal. 1. I am landing. 2. Directs indicated aircraft to land.	1. Nods. ("I understand") or waves goodby. 2. Aircraft indicated repeats signal, blows a kiss and executes.
Open hand held vertically and moved forward or backward, palm in direction of movement.		Adjust wing position forward or aft.	Wingman moves in direction indicated.
Open hand held horizontally and moved slowly up or down, palm in direction of movement.		Adjust wing position up or down	Wingman moves up or down as indicated.

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Figure 7-24. Visual Communications (Sheet 2)

Visual Communications

TAKEOFF, CHANGING LEAD, LEAVING FORMATION BREAKUP, LANDING

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Open hand used as if beckoning inboard or pushing outboard		Adjust wing position laterally toward or away from leader.	Wingman moves in direction indicated.
Hand opened flat and palm down, simulating dive or climb.		I am going to dive or climb.	Prepare to execute.
Hand moved horizontally above glareshield, palm down.		Leveling off.	Prepare to execute.
Two fingers pointed toward eyes (meaning IFF/SIF signals), followed by: 1. CUT 2. 3-digit numerals		1. Turn IFF/SIF to "STANDBY". 2. Set mode and code indicated: first numeral-mode, second and third numerals-code.	Repeat, then execute.
Head moved backward.		Slow down.	Execute.
Head moved forward.		Speed up.	Execute.
Head nodded right or left.		I am turning right or left.	Prepare to execute.
Thumb waved backward over shoulder.	Series of 00's in code, given by external lights.	Take cruising formation or open up.	Execute.
1. Holds up right (or left) forearm vertically, with clenched fist or single wing-dip.	1. Single letter R (or K) in code, given by external lights.	1. Wingman cross under to right (or left) echelon or in direction of wing-dips.	1. Execute.
2. Same as above, except with pumping motion or double wing-dip.	2. Series of RR's (or KK's) in code, given by external lights.	2. Section cross under to right (or left) echelon or in direction of wing-dips.	2. Execute.
Triple wing-dip.		Division cross under.	Execute.
	Series of VV's in code, given by external lights.	Form a Vee or balanced formation.	Execute.
Series of zooms.	Series of XX's in code, given by external lights.	Close up or join up; join up on me.	Execute.
Rocking of wings by leader.		Prepare to attack.	Execute preparation to attack.
Rocking of wings by any other member of flight.		We are being, or are about to be, attacked.	Stand by for and execute defensive maneuvers.
Lead plane swishes tail		All aircraft in this formation form step-down column in tactical order behind column leader.	Execute. Leader speeds up slightly to facilitate formation of column.
Shaking of ailerons. Head raised then lowered	Long dash, given with external lights.	Execute signal; used as required in conjunction with another signal.	Execute last signal given.
Open and close four fingers and thumb	3 dashes with external lights	Extend or retract speed brake as appropriate.	Repeat signal. Execute upon head-nod from leader or when leader's speed brake extends/retracts.
Rotary movement of clenched fist in cockpit as if cranking wheels, followed by head nod.	2 dashes with external lights	Lower or raise landing gear and flaps, as appropriate.	Repeat signal. Execute when leader changes configuration.
Pointing index finger toward runway/ship in stabbing motion, repeatedly, followed by lead change signal.	1 dash with external lights	Landing runway or ball and ship in sight.	Ashore: Take position for landing Carrier: Breakoff and land

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Figure 7-24. Visual Communications (Sheet 3)

Visual Communications

TAKEOFF, CHANGING LEAD, LEAVING FORMATION, BREAKUP, LANDING

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Raised fist with thumb extended in drinking position		How much fuel have you?	Repeat signal, then indicate fuel in hundreds of pounds by finger–numbers.
Leader lowers hook.	Letter H in code, given by external lights.	Lower arresting hook.	Wingman lower arresting hook. Leader indicates wingman's hook is down with thumbs–up signal.
Open hand held up, fingers together, moved in fore–and–aft chopping motion (by leader).		Course to be steered is present compass heading.	Nod of head ("I understand").

ELECTRONIC COMMUNICATIONS AND NAVIGATION

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Tap earphones, followed by patting of head, and point to other aircraft.		Take over communications.	Repeat signals, pointing to self, and assume communications lead.
Tap earphones, followed by patting of head.		I have taken over communications.	Nod ("I understand").
Tap earphones and indicate by finger–numerals, number of channel to which shifting.		Shift to channel indicated by numerals.	Repeat signal and execute.
Vertical hand, with fingers pointed ahead and moved in a horizontal sweeping motion, with four fingers extended and separated.		What is bearing and distance to the TACAN station?	Wait signal, or give magnetic bearing and distance with fingers – numerals. The first three numerals indicate magnetic and the last two or three, distance.

VISUAL EMERGENCY SIGNALS (AIR-TO-AIR)

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Arms bent across forehead weeping	Horizontal motion of flashlight shone at other aircraft.	General emergency signal meaning, I am in trouble.	Carry out squadron doctrine for escort of disabled aircraft.
Landing motion with open hand	Circular motion of flashlight shone at other aircraft.	I must land immediately.	Assume lead if indicated and return to base or nearest suitable field.
Point to pilot and give series of thumbs down movements	Flash series of dots with exterior lights.	Are you having difficulty?	Thumbs up: I am all right. Thumbs down: I am having trouble. Lights off once then on steady: I am allright. Lights flashing: I am having trouble.

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Figure 7–24. Visual Communications (Sheet 4)

Visual Communications

ARMAMENT

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
1. Pistol-cocking motion with either hand. 2. Followed by question-signal. 3. Followed by thumbs-down signal.		1. Ready or safety guns. 2. How much ammo do you have? 3. I am unable to fire.	1. Repeat signal and execute. 2. Thumbs up-"over half"; thumbs down-" less than half." 3. Nod head ("I understand").
1. Shaking fist. 2. Followed by question-signal. 3. Followed by thumbs-down signal.		1. Arm or safety bombs, as applicable. 2. How many bombs do I have? 3. I am unable to drop.	1. Repeat signal and execute. 2. Indicate with appropriate finger-numerals. 3. Nod head ("I understand").
1. Shaking hand, with fingers extended downward. 2. Followed by question-signal. 3. Followed by thumbs-down signal.		1. Arm or safety missile/rockets as applicable. 2. How many missiles/rockets do I have? 3. I am unable to fire.	1. Repeat signal and execute. 2. Indicate with appropriate finger-numerals. 3. Nod head ("I understand").
Pistol cocking motion with either hand, followed by fore and aft pulling motion with a clenched fist.	1. Strobe light ON and OFF by lead aircraft. 2. Strobe light turned ON for second time (allow time for setting up switches).	Jettison external stores. 1. Set up your switches for jettison 2. You are cleared to drop	Repeat signal and execute. 1. Set up jettison/ordnance switches. 2. Execute.

AIR REFUELING

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
One finger turn-up signal Form cone-shape with hand, all fingers extended aft (make signal close to canopy). 1. Cone moved aft 2. Cone moved forward		By receiver: start turbine 1. By receiver: extend drogue. 2. By receiver: retract	Tanker execute. Receiver gives thumbs-up when turbine starts. Tanker execute. Receiver give thumbs-up if: 1. Drogue extends properly. 2. Drogue retracts fully and air turbine feathers.
Make hand into cupshape, then make repeated pouring motions		By tanker: I am going to dump fuel.	By receiver: Nod. Give thumbs-up when fuel dumping commences.
Slashing motion of index finger across throat		By tanker: I have stopped dumping fuel.	By receiver: Give thumbs-up if fuel dumping has ceased.

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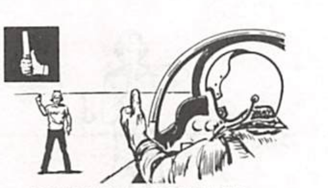
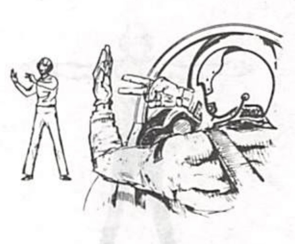
Figure 7-24. Visual Communications (Sheet 5)

Deck Ground Handling Signals



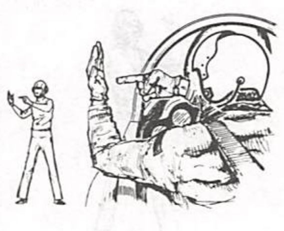
ACKNOWLEDGEMENT

A CLENCHED FIST WITH THUMB POINTING STRAIGHT UP INDICATES SATISFACTORY COMPLETION OF A CHECK ITEM. A CLENCHED FIST WITH THUMB POINTING STRAIGHT DOWN INDICATES UNSATISFACTORY COMPLETION AND/OR DO NOT CONTINUE.



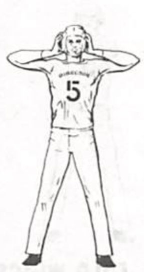
INSERT/PULL ELECTRICAL POWER

PILOT INSERTS/PULLS INDEX AND MIDDLE FINGER TO/FROM OPEN PALM. SIGNALMAN RESPONDS WITH SAME SIGNAL



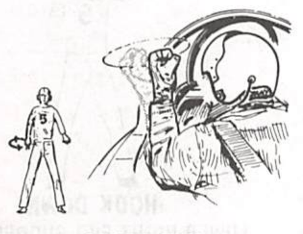
INSERT/PULL EXTERNAL AIR

PILOT INSERTS/PULLS INDEX FINGER TO/FROM OPEN PALM, SIGNALMAN RESPONDS WITH SAME SIGNAL.



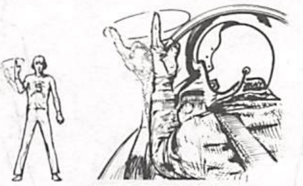
GROUND INTERCOM

CUP HANDS OVER EARS OR POINT WANDS TO EARS.



START APU

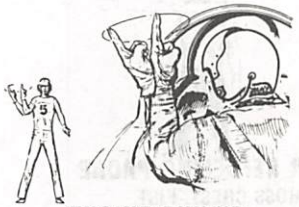
PILOT MOVES CLENCHED FIST IN CIRCULAR MOTION IN VIEW OF SIGNALMAN.



START ENGINE

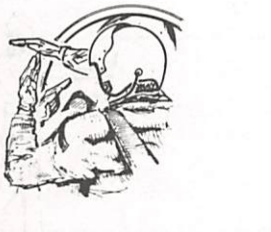
PILOT EXTENDS FINGERS TO INDICATE WHICH ENGINE IS READY FOR START IF ALL CLEAR, SIGNALMAN RESPONDS WITH SIMILAR GESTURE POINTING AT PROPER ENGINE WHILE ROTATING OTHER HAND IN CLOCKWISE MOTION

1 FINGER – LEFT ENGINE
2 FINGERS – RIGHT ENGINE



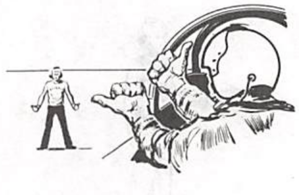
ENGINE RUN-UP

PILOT MOVES INDEX FINGER IN CIRCULAR MOTION INDICATING HE IS READY TO RUN UP ENGINE, SIGNALMAN RESPONDS WITH SIMILAR SIGNAL WHEN ALL CLEAR.



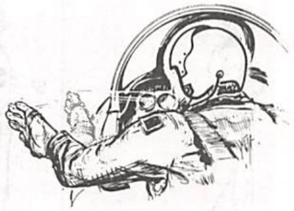
CHECK NOSE WHEELWELL DDI

PILOT MAKES T WITH HANDS AND POINTS TO NOSE



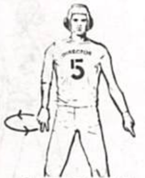
PULL CHOCKS

PILOT MAKES SWEEPING MOTION OF FISTS WITH THUMBS EXTENDED OUTWARD. SIGNALMAN SWEEPS FISTS APART AT HIP LEVEL WITH THUMBS EXTENDED OUTWARD.



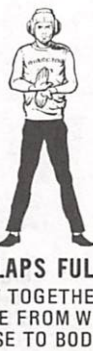
AM I CLEAR UNDERNEATH

WITH LEFT HAND OPEN, PALM OUT, PILOT MAKES SWEEPING MOTION ACROSS COCKPIT FROM RIGHT TO LEFT.



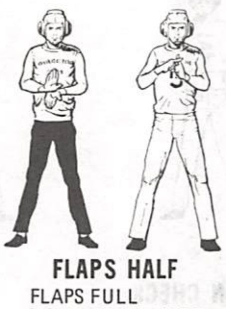
START APU

POINTS TO APU EXHAUST WITH LEFT HAND INDEX FINGER: MOVES RIGHT HAND IN HORIZONTAL CIRCLE, INDEX AND MIDDLE FINGER POINTED DOWN.
NIGHT: SAME AS DAY EXCEPT WITH WANDS MAKES THROAT CUTTING SIGNAL WITH LEFT HAND WHILE RIGHT HAND MAKES APU SIGNAL TO SHUT DOWN APU.



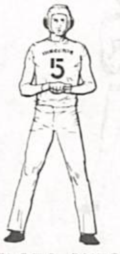
FLAPS FULL

HANDS FLAT TOGETHER, THEN OPENED WIDE FROM WRISTS. ARM IN CLOSE TO BODY.



FLAPS HALF

FLAPS FULL SIGNAL FOLLOWED BY CROSSED INDEX FINGERS



FLAPS AUTO

HANDS, OPENED WIDE FROM WRIST, SUDDENLY CLOSED, ARMS IN CLOSE TO BODY.

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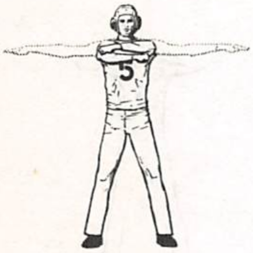
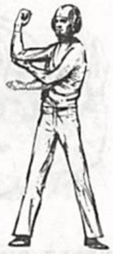
Figure 7-25. Deck Ground Handling Signals (Sheet 1 of 3)

Deck Ground Handling Signals



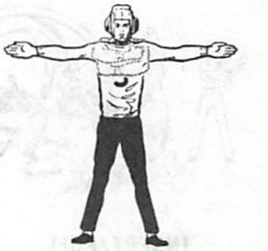
FOLD WINGS

ARMS, FROM STRAIGHT OUT SWEPT IN TO HUG SHOULDER.



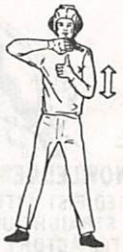
WING LOCK

EXTEND ARM TO SIDE, LEVEL WITH SHOULDER BEND ARM UPWARD, AND SLAP ELBOW



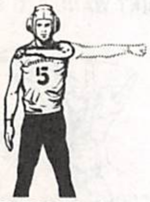
SPREAD WINGS

ARMS IN HUGGING POSITION, THEN SWEPT OUT TO SIDES.



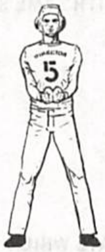
EXTEND LAUNCH BAR

RIGHT PALM CUPPED OUTWARDS, LEFT THUMB SWEPT ACROSS IT.



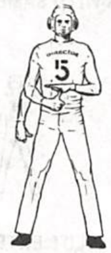
AIR REFUELING PROBE

ARM ACROSS CHEST, FIST CLENCHED. EXTEND ARM HORIZONTALLY TO THE SIDE POSITION. USE LEFT ARM FOR AIR REFUELING PROBE AND RIGHT ARM FOR RAT. REVERSE THE PROCEDURE FOR RETRACT.



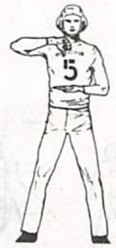
SPEED BRAKE

EXTEND ARMS AT WAIST WITH PALMS TOGETHER. KEEP WRISTS TOGETHER AND OPEN PALMS.



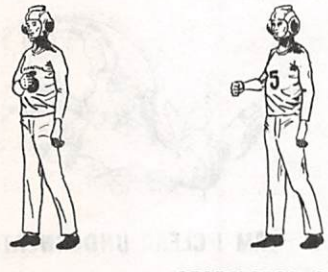
HOOK UP

RIGHT THUMB JERKED UP TO MEET HORIZONTAL LEFT HAND.



HOOK DOWN

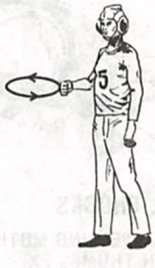
LOWER RIGHT FIST SUDDENLY, THUMB EXTENDED DOWNWARD, TO MEET HORIZONTAL PALM OF LEFT HAND HELD IN FRONT OF BODY



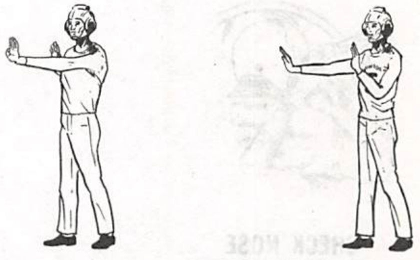
STABILATOR CHECK

STICK AFT
LEADING EDGE DOWN

STICK FWD
LEADING EDGE UP



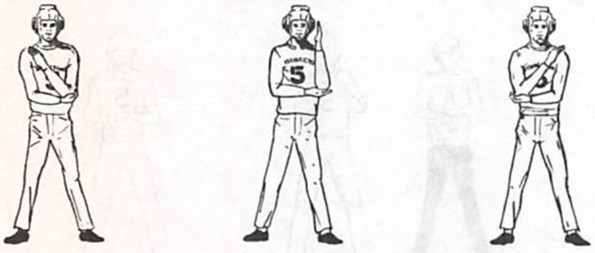
EXERCISER
OR FCS BIT



RUDDER CHECK

LEFT RUDDER IN
RUDDER SWINGS LEFT

RIGHT RUDDER IN
RUDDER SWINGS RIGHT

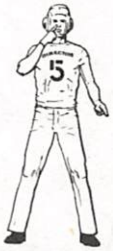


AILERON CHECK

LEFT STICK
RIGHT AILERON DOWN

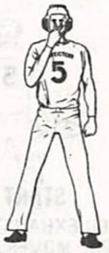
NEUTRAL STICK
AILERON UP

RIGHT STICK
LEFT AILERON DOWN



NOSE GEAR STEERING

RIGHT INDEX FINGER POINTING TO RIGHT SIDE OF NOSE FOR RIGHT TURN AND VICE VERSA FOR LEFT TURN; OPPOSITE HAND POINTING TO NOSE GEAR.



EXTERIOR LIGHTS

HOLD THE INDEX AND MIDDLE FINGER IN A "V" SIGNAL POINTING TOWARDS THE EYES.

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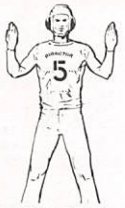
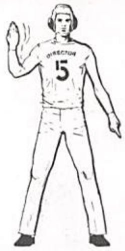
Figure 7-25. Deck Ground Handling Signals (Sheet 2)

Deck Ground Handling Signals



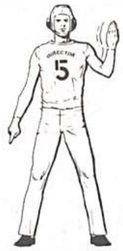
COME AHEAD

HANDS AT EYE LEVEL, EXECUTE MOTION: RATE OF MOTIONS INDICATES DESIRED SPEED OF AIRCRAFT. FOR NIGHT OPERATION, WAVE WANDS SIDE TO SIDE.



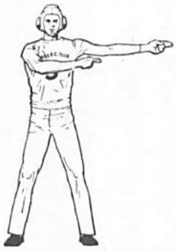
RIGHT TURN

PULL DESIRED WING AROUND WITH REGULAR "COME AHEAD". POINT AT OPPOSITE BRAKE.



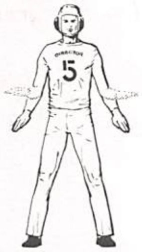
LEFT TURN

PULL DESIRED WING AROUND WITH REGULAR "COME AHEAD". POINT AT OPPOSITE BRAKE.



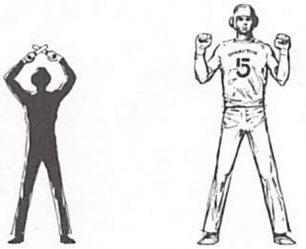
TURNOVER OF COMMAND

BOTH HANDS POINTED AT NEXT SUCCEEDING TAXI SIGNALMAN.



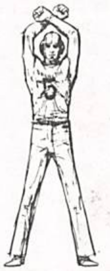
SLOW DOWN

DOWNWARD PATTING MOTION, HANDS OUT AT WAIST LEVEL.



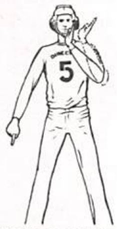
STOP

ARMS UPRAISED, FISTS CLENCHED AND HELD IN SIMPLE "POLICEMAN'S STOP".



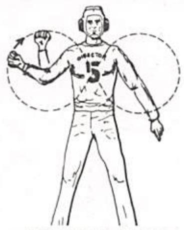
EMERGENCY STOP

ARMS CROSSED ABOVE HEAD FISTS CLENCHED.



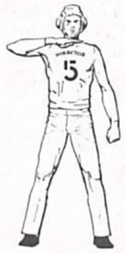
HOT BRAKES

MAKE RAPID FANNING MOTION WITH ONE HAND IN FRONT OF FACE. POINT TO WHEEL WITH OTHER HAND.



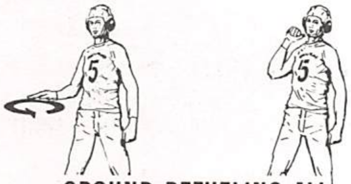
ENGINE FIRE

DESCRIBE A LARGE FIGURE EIGHT WITH ONE HAND AND POINT TO THE FIRE AREA WITH THE OTHER HAND.



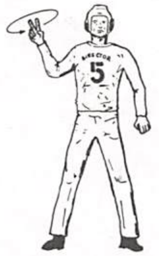
CUT ENGINE

HAND DRAWN ACROSS NECK IN "THROAT CUTTING" MOTION.



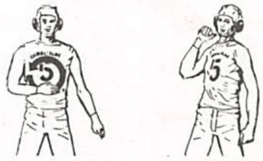
GROUND REFUELING ALL TANKS, NO EXTERNAL POWER

CIRCULAR MOTION PARALLEL TO THE HORIZON WITH ONE HAND EXTENDED FOLLOWED BY A DRINKING MOTION (THUMB TO MOUTH).



FINAL READY

TWO FINGERS IN CIRCULAR MOTION



GROUND REFUELING INTERNAL TANKS NO EXTERNAL POWER

CIRCULAR MOTION WITH THE PALM OF HAND TOWARD STOMACH (AS RUBBING STOMACH) FOLLOWED BY A DRINKING MOTION (THUMB TO MOUTH).

NIGHT SIGNALS

NIGHT SIGNALS ARE THE SAME AS DAY SIGNALS EXCEPT AS NOTED, FLASHLIGHTS OR WANDS WILL SUBSTITUTE FOR HAND AND FINGER MOVEMENTS DURING NIGHT OPERATIONS.

DECK PERSONNEL COLOR CODING

REFER TO CVA/CVS NATOPS MANUAL

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Figure 7-25. Deck Ground Handling Signals (Sheet 3)

SECTION VIII

WEAPONS SYSTEMS

TABLE OF CONTENTS

PART 1 - WEAPONS SYSTEM OVERVIEW *
PART 2 - AIR-TO-AIR WEAPONS SYSTEM *
PART 3 - AIR-TO-GROUND WEAPONS SYSTEM *
PART 4 - SOFTWARE *
PART 5 - DATA LINK *
PART 6 - RADAR BEACON *
PART 7 - DEFENSIVE ELECTRONIC COUNTERMEASURES *
PART 8 - TACTICAL AIRCREW COMBAT TRAINING SYSTEM *

*Refer to Supplemental Flight Manual, A1-F18AC-NFM-100.

SECTION IX

FLIGHT CREW COORDINATION

To be supplied.

SECTION X

NATOPS EVALUATION

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NATOPS Evaluation Program 10-1
  Concept 10-1
  Implementation 10-1
  Definitions 10-1
Ground Evaluation 10-2
Flight Evaluation 10-3
  Flight Evaluation Grade Determination 10-4
  Final Grade Determination 10-4
  Records and Reports 10-4
NATOPS Evaluation Question Bank 10-5

NATOPS EVALUATION PROGRAM

CONCEPT

The standard operating procedures prescribed in this manual represent the optimum method of operating the F/A–18 airplane. The NATOPS Evaluation is intended to evaluate compliance with NATOPS procedures by observing and grading individuals and units. This evaluation is tailored for compatability with various operational commitments and missions of both Navy and Marine Corps units. The prime objective of the NATOPS Evaluation program is to assist the unit commanding officer in improving unit readiness and safety through constructive comment. Maximum benefit from the NATOPS Program is achieved only through the vigorous support of the program by commanding officers as well as pilots.

IMPLEMENTATION

The NATOPS Evaluation program shall be carried out in every unit operating naval aircraft. Pilots desiring to attain/retain qualification in the F/A–18 shall be evaluated initially in accordance with OPNAV Instruction 3510.9 series, and at least once during the twelve months following initial and subsequent evaluations. Individual and unit NATOPS Evaluations will be conducted annually; however, instruction in and observation of adherence to NATOPS procedures must be on a daily basis within each unit to obtain maximum benefits from the program. The NATOPS Coordinators, Evaluators, and Instructors shall administer the program as outlined in OPNAVINST 3510.9 series. Evaluees who receive a grade of Unqualified on a ground or flight evaluation shall be allowed 30 days in which to complete a reevaluation. A maximum of 60 days may elapse between the date the initial ground evaluation was commenced and the date the flight evaluation is satisfactorily completed.

DEFINITIONS

The following terms, used throughout this section, are defined as to their specific meaning within the NATOPS program.

NATOPS EVALUATION

A periodic evaluation of individual pilot standardization consisting of an open book examination, a closed book examination, an oral examination, and a flight evaluation.

NATOPS REEVALUATION

A partial NATOPS Evaluation administered to a pilot who has been placed in an Unqualified status by receiving an Unqualified grade for any of his ground examinations or the flight evaluations. Only those areas in which an unsatisfactory level was noted need be observed during a reevaluation.

QUALIFIED

Well standardized; evaluee demonstrated highly professional knowledge of and compliance with NATOPS standards and procedures; momentary deviations from or minor omission in non–critical areas are permitted if prompt and timely remedial action is initiated by the evaluee.

CONDITIONALLY QUALIFIED

Satisfactorily standardized; one or more significant deviations from NATOPS standards and procedures, but no errors in critical areas and no errors jeopardizing mission accomplishment or flight safety.

UNQUALIFIED

Not acceptably standardized; evaluee fails to meet minimum standards regarding knowledge of and/or ability to apply NATOPS procedures, one or more significant deviations from NATOPS standards and procedures which could jeopardize mission accomplishment or flight safety.

AREA

A routine of preflight, flight or postflight.

SUB–AREA

A performance sub–division within an area, which is observed and evaluated during an evaluation flight.

CRITICAL AREA/SUB–AREA

Any area or sub–area which covers items of significant importance to the overall mission requirements, the marginal performance of which would jeopardize safe conduct of the flight.

EMERGENCY

An airplane component, system failure, or condition which requires instantaneous recognition, analysis, and proper action.

MALFUNCTION

An airplane component or system failure or condition which requires recognition and analysis, but which permits more deliberate action than that required for an emergency.

GROUND EVALUATION

GENERAL

Prior to commencing the flight evaluation, an evaluee must achieve a minimum grade of Qualified on the open book and closed book examinations. The oral examination is also part of the ground evaluation but may be conducted as part of the flight evaluation. To assure a degree of standardization between units, the NATOPS instructors may use the bank of questions contained in this section in preparing portions of the written examinations.

OPEN BOOK EXAMINATION

The open book examination shall consist of, but not be limited to, the question bank. The purpose of the open book examination portion of the written examination is to evaluate the pilot's knowledge of appropriate publications and the airplane.

CLOSED BOOK EXAMINATION

The closed book examination may be taken from, but not limited to, the question bank and shall include questions concerning normal/emergency procedures and airplane limitations. Questions designated critical will be so marked.

ORAL EXAMINATION

The questions may be taken from this manual and drawn from the experience of the Instructor/Evaluator. Such questions should be direct and positive and should in no way be opinionated.

OFT/WST PROCEDURES EVALUATION

An OFT may be used to assist in measuring the pilot's efficiency in the execution of normal operating procedures and his reaction to emergencies and malfunctions. In areas not served by an OFT, this may be done by placing the pilot in an airplane and administering appropriate questions.

NAMT SYSTEMS CHECK

If desired by the individual squadron, Naval Air Maintenance Trainer facilities may be utilized to evaluate pilot knowledge of airplane systems and normal and emergency procedures.

GRADING INSTRUCTIONS

Examination grades shall be computed on a 4.0 scale and converted to an adjective grade of Qualified or Unqualified.

Open Book Examination

To obtain a grade of Qualified, an evaluee must obtain a minimum score of 3.5.

Closed Book Examination

To obtain a grade of Qualified, an evaluee must obtain a minimum score of 3.3.

Oral Examination and OFT Procedure Check (If Conducted)

A grade of Qualified or Unqualified shall be assigned by the Instructor/Evaluator.

FLIGHT EVALUATION

GENERAL

The flight evaluation should be conducted in an OFT but may be conducted on any routine syllabus flight with the exception of flights launched for FCLP/CARQUAL training. Emergencies will not be simulated unless flight is accomplished in a TF/A-18 with a qualified IP in the rear seat.

The number of flights required to complete the flight evaluation should be kept to a minimum; normally one flight. The areas and sub-areas to be observed and graded on a flight evaluation are outlined in the grading criteria with critical areas marked by an asterisk (*). Sub-area grades will be assigned in accordance with the grading criteria. These sub-areas shall be combined to arrive at the overall grade for the flight. Area grades, if desired, shall also be determined in this manner.

FLIGHT EVALUATION

The areas and sub-areas in which pilots may be observed and graded for adherence to standarized operating procedures are outlined in the following paragraphs.

NOTE

- If desired, units with training missions may expand the flight evaluation to include evaluation of standardized training methods and techniques.
- The IFR portions of the Flight Evaluation shall be in accordance with the procedures outlined in the NATOPS Instrument Flight Manual.

MISSION PLANNING/BRIEFING

a. Flight Planning.
b. Briefing.
c. Personal Flying Equipment (*)

PREFLIGHT/LINE OPERATIONS

Inasmuch as preflight/line operations procedures are graded in detail during the ground evaluation, only those areas observed on the flight check will be graded.

a. Airplane Acceptance
b. Start
c. Before Taxiing Procedures

TAXI/RUN UP

TAKEOFF (*)

a. ATC Clearance
b. Takeoff

CLIMB/CRUISE

a. Departure
b. Climb and Level-Off
c. Procedures Enroute

APPROACH/LANDING (*)

a. Tacan, GCA, ILS/ACLS, Radar, ADF
b. Landing

COMMUNICATIONS

a. R/T Procedures
b. Visual Signals
c. IFF Procedures

EMERGENCY/MALFUNCTION PROCEDURES (*)

In this area, the pilot will be evaluated only in the case of actual emergencies, unless evaluation is conducted in the OFT/WST or TF/A-18.

POST FLIGHT PROCEDURES

a. Taxi
b. Shutdown
c. Inspection and Records
d. Flight Debriefing

MISSION EVALUATION

This area includes missions covered in the NATOPS Flight Manual, F/A–18 Tactical Manual, and NWP NWIP's for which standardized procedures/techniques have been deployed.

APPLICABLE PUBLICATIONS

The NATOPS Flight Manual contains the standard operations criteria for F/A–18 airplanes. Publications relating to environmental procedures peculiar to shorebased and shipboard operations and tactical missions are F/A–18 Tactical Manual, NWP's, NWIP's, ATC/CATCC Manual, Local Air Operations Manual, and Ship Air Operations Manual.

FLIGHT EVALUATION GRADING CRITERIA

Only those sub–areas provided or required will be graded. The grades assigned for a sub–area shall be determined by comparing the degree of adherence to standard operating procedures with adjectival ratings listed below. Momentary deviations from standard operating procedures should not be considered as unqualifying provided such deviations do not jeopardize flight safety and the evaluee applies prompt corrective action.

FLIGHT EVALUATION GRADE DETERMINATION

The following procedure shall be used in determining the flight evaluation grade: A grade of Unqualified in any critical area/sub–area will result in an overall grade of Unqualified for the flight. Otherwise, flight evaluation (or area) grades shall be determined by assigning the following numerical equivalents to the adjective grade for each sub–area. Only the numerals 0, 2 or 4 will be assigned in sub–area. No interpolation is allowed.

Unqualified	0.0
Conditionally qualified	2.0
Qualified	4.0

To determine the numerical grade for each area and the overall grade for the flight, add all the points assigned to the sub–areas and divide this sum by the number of sub–areas graded. The adjective grade shall then be determined on the basis of the following scale.

0.0 to 2.19 – Unqualified
2.2 to 2.99 – Conditionally Qualified
3.0 to 4.0 – Qualified

EXAMPLE: (Add Sub–area numerical equivalents)

$(4+2+4+2+4) \div 5 = 3.20$ Qualified

FINAL GRADE DETERMINATION

The final NATOPS Evaluation grade shall be the same as the grade assigned to the flight evaluation. An evaluee who receives an Unqualified on any ground examination or the flight evaluation shall be placed in an Unqualified status until he achieves a grade of Conditionally Qualified or Qualified on a reevaluation.

RECORDS AND REPORTS

A NATOPS Evaluation Report (OPNAV Form 3510–8) shall be completed for each evaluation and forwarded to the evaluee's commanding officer only. This report shall be filed in the individual NATOPS Flight Personnel Training/Qualification jacket and retained therein for 18 months.

CRITIQUE

The critique is the terminal point in the NATOPS evaluation and will be given by the Evaluator/Instructor administering the check. Preparation for the critique involves processing, reconstructing data collected, and oral presentation of the NATOPS Evaluation Report. Deviations from standard operating procedures will be covered in detail using all collected data and worksheets as a guide. Upon completion of the critique, the pilot will receive the completed copy of the NATOPS Evaluation Report for certification and signature. The completed NATOPS Evaluation Report will then be presented to the Unit Commanding Officer.

NATOPS EVALUATION QUESTION BANK

The following bank of questions is intended to assist the unit NATOPS Instructor/Evaluator in the preparation of ground examinations and to provide an abbreviated study guide. The questions from the bank may be combined with locally originated questions in the preparation of ground examinations. The closed book exam will consist of no less than 50 questions. The time limit for the closed book exam is 1 hour and 30 minutes. The requirements for the open book exam are the same as those for the closed book exam, except there is no time limit.

NATOPS EVALUATION QUESTION BANK

1. What is the F/A–18's operating weight?

2. What is the takeoff gross weight (operating weight plus full internal fuel, ammo, 2 AIM–7's, 2 AIM–9's)?

3. What is military thrust of the F404–GE–400 engine?

4. What is afterburner thrust of the F404–GE–400 engine?

5. When will you get engine ignition?

   a.
   b.
   c.
   d.

6. When will you get afterburner ignition?

   a.
   b.

7. How is a limited amount of fuel provided for negative G or inverted flight?

8. True/False: The F/A–18's IDLE rpm is the same on the ground as inflight.

9. Which one of the following caution and advisory displays will not activate the "engine left (right)" voice alert?

   a. L or R OVRSPD
   b. L or R EGT HIGH
   c. L or R BOOST LO
   d. L or R OIL PR

10. What are the modes of operation of the automatic throttle control (ATC)?

    a.
    b.

11. What conditions must be met to engage the approach mode of the automatic throttle control?

    a.
    b.
    c.

CONTINUED

12. What conditions must be met to engage the CA mode of the automatic throttle control?

    a.
    b.

13. Which fuel tanks are transfer tanks?

    a.
    b.
    c.

14. Which fuel tanks are feed tanks?

    a.
    b.

15. What does a TANK PRESS caution display on the DDI indicate?

    a. On the ground –
    b. Inflight –

16. Normal internal fuel is transferred using . . . .

17. External fuel is transferred by . . . .

18. True/False: With external tank control switch in stop transfer and hook handle down, fuel will transfer when FUEL LO caution display comes on.

19. What two fuel valves close when an engine fire light is pressed?

    a.
    b.

20. List 4 events which individually will cause fuel dump to stop.

    a.
    b.
    c.
    d.

21. True/False: The fuel low level indicating system is completely independent of the fuel quantity indicating system.

22. What fuel state illuminates the FUEL LO Light, Master Caution Light, and activates Fuel Low voice alert?

23. True/False: There is no voice alert associated with BINGO fuel

24. Either AMAD may be driven pneumatically through an . . . . by the APU, opposite engine bleed air, or external air.

25. Each AMAD mechanically drives a . . . . , ... , and . . . .

26. True/False: Operation of APU is totally automatic after the APU switch is placed ON.

27. What provides electrical power for APU ignition and start control circuits?

28. What is used to start the APU?

29. True/False: If ATS caution is on when the right DDI comes on, shut down the affected engine to avoid starter damage.

30. What is the cockpit warning of a single transformer–rectifier failure?

CONTINUED

31. What is indicated by the BATT SW light coming on in the air with the battery switch on?

32. What 8 circuit breakers are located in the cockpit?

33. True/False: The exterior lights master switch must be on for operation of the position and formation lights, but not for the strobe lights.

34. What failure(s) will illuminate the emergency instrument light and the BATT SW caution light?

35. The right or HYD system 2 provides power to:

36. What are the primary and two backup modes of the flight control system.
a.
b.
c.

37. What are the primary flight controls?

38. What does pressing the T/O trim button in flight do?

39. What is the FCS reset button used for?

40. With the spin switch in NORM, when will the spin recovery mode be activated?

41. What does having the flight controls in a spin recovery mode do for you as a pilot?

42. What position are the flaps in when the flight controls are in a spin recovery mode?

a.
b.

43. On takeoff, accelerating with the flaps switch in HALF, at what speed will the flaps begin AUTO scheduling?

44. What bus powers FCC A?

45. What bus powers FCC B?

46. True/False: Once EMERG has been selected on FCS cool switch, selection of NORM will switch FCC A and right TR cooling back to avionics air.

47. Rudder toe–in is a function of flap switch position and . . . . with maximum toe–in being . . . .

48. What directly controls stick movement with flight controls in the MECH mode?

49. True/False: An R OFF caution display indicates that the roll axis is now in the direct electrical link mode.

50. True/False: An FCS 1ST caution dislay is accompanied by a flight controls, flight controls voice alert.

51. True/False: Stabilator position on the FCS status display on the DDI shows a (+) for trailing edge up (or nose up), and a (–) for trailing edge down (or nose down).

52. What occurs with gear handle UP, airspeed below 175 knots, altitude less than 7500 feet, and rate of descent greater than 250 feet per minute?

a.
b.

53. True/False: Pushing the nosewheel steering button a second time will select the high mode (±75°) and NWS HI is displayed on the HUD.

54. True/False: The hook light remains on except when the hook is up and latched.

55. Normally, what kind of power is needed to fold or spread the wings?

56. Is it normal to have L PITOT HT and R PITOT HT advisories dislayed on the DDI while on the ground with pitot heat switch in AUTO?

57. What will the standby attitude indicator be powered by if the right 115 volt ac bus fails?

58. The APU fire detection/extinguishing systems operates from . . . . power, provided the . . . . switch is ON.

59. The bleed air shutoff valves are closed when the fire and bleed air test switch is placed to TEST A and TEST B positions. How do you get the valves back open?

a.
b.

60. True/False: The canopy can be jettisoned in the closed position only.

61. Why would you not pull the manual override handle in flight before ejection?

62. What conditions must be met to utilize the emergency jettison button?

a.
b.

63. The . . . . switch must be in the . . . . position to use the selective jettison system.

64. What occurs when the unlighted MASTER CAUTION light is pressed?

65. True/False: For cautions with voice alert, the master caution tone comes on after the voice alert.

66. What two ways can you stop any BIT test in progress and return the equipment to normal operation?

a.
b.

67. What two systems require additional switchology other than pressing the associated button when performing initiated BIT checks?

a.
b.

68. How much has the fuel quantity in tank 1 been reduced in the TF/A-18 airplane?

69. True/False: The aft cockpit does not have an internal canopy switch or an internal manual canopy handcrank.

70. True/False: There are provisions for normal landing gear extension from the rear cockpit.

71. The leg restraint lines must be buckled at all times during flight to ensure . . . . and to enhance . . . .

72. Failure to route the restraint lines properly through the garters could cause:

73. True/False: High gain nosewheel steering should be used on takeoff roll up to 50 knots.

74. On a section takeoff, turns into the wingman will not be made at altitudes less than . . . . . feet AGL.

75. True/False: The second section may commence the takeoff roll after the first section has rolled 1000 feet.

76. True/False: Before descent it is necessary to preheat the windshield by increasing defog airflow.

77. A landing touchdown is made utilizing the mirror or land at least . . . . . feet past the runway threshold.

CONTINUED

78. True/False: For optimum braking above 40 knots, with anti-skid, full brake pressure should be used.

79. True/False: Ensure anti-skid is OFF for all shipboard operations.

80. Nosewheel steering low mode (may/may not) be engaged while the launch bar is down (circle correct answer).

81. A carrier landing pattern starts with a level break at . . . . . . feet, ... knots on the . . . . bow of the ship.

82. Name three general rules that apply to all emergency situations.

a.
b.
c.

83. True/False: The seat rocket thrusters may ignite spilled fuel or hydraulic fluid and may injure ground crew in the immediate vicinity.

84. True/False: If you must land with the launch bar extended, you should request that the field arresting gear cables be removed.

85. A time critical situation exists if you have directional control problems during takeoff. If you suspect nosewheel steering failure, the first thing you should do is:

1.

86. If the aircraft begins to settle after a catapult launch and the settling cannot be stopped you must . . . .

87. If you have lost thrust on takeoff:

1.
2.
3.
4.

88. True/False: It is unlikely that a blown tire will FOD an engine.

89. During flight brief consideration of takeoff abort possibilities, the following items should be considered.

a. Weight
b. Speed
c. Runway length remaining
d. All of the above

90. When making an arrested abort, allow time for the arresting hook to extend; as a guide, lower the hook . . . . . . feet before the cable.

91. If the landing gear fails to retract you should perform the following:
a. Pull the landing gear control circuit breaker.
b. Cycle the gear and pull negative G's.
c. Put the landing gear handle down and do not cycle
d. Press on – its probably a false light.

92. True/False: If you have a failed engine and the engine core is rotating freely and rpm is below 30% use the APU or engine crossbleed to retain both HYD systems.

93. True/False: If the right engine is being rotated with crossbleed to provide normal systems operation and fuel flow on the left engine is reduced below 2000 PPH (as during landing) the right engine hydraulic pump may not provide sufficient flow for nosewheel steering and normal brakes.

94. True/False: Most engine stalls are self clearing.

CONTINUED

95. True/False: Engine stalls may produce audible bangs.

96. True/False: If a stalled engine will not clear, you may shut down the engine and attempt a restart.

97. What airspeed may be required to maintain 12% windmilling rpm?

98. True/False: Engine crossbleed may not be used to achieve a 12% rpm for engine restart.

99. With one engine windmilling below 12%, the remaining engine should be operated at or above . . . . % rpm and . . . . . . PPH fuel flow to utilize the crossbleed airstart capability.

100. True/False: Hydraulic system 2A failure is the only single hydraulic system failure which requires pilot action.

101. Hydraulic system 1A does not power which of the following;

a. Right Aileron
b. Right Trailing Edge Flap
c. Leading Edge Flaps
d. Left Trailing Edge Flaps

102. True/False: With HYD 2A failure, anti-skid is available.

103. With HYD 2A and/or 2B failure what type of landing should be considered?
a. Normal landing
b. Formation landing
c. Long field arrestment
d. Short field arrestment if possible

104. True/False: Gravity fuel flow is sufficient to sustain minimum afterburner operation.

105. True/False: You are in the spooldown restart envelope at 450 knots, 23,000 feet and N_2 50%.

106. True/False: You are in the windmill restart envelope at .75 Mach, 25,000 feet and 14% N_2.

107. True/False: A crossbleed restart is recommended at .68 Mach and 10,000 feet.

108. True/False: As a last resort, you may attempt an APU restart at 250 knots and 10,000 feet.

109. True/False: An APU restart should be one of the first procedures you utilize after an engine failure.

110. True/False: If tank 1 fails to transfer, as much as 1100 pounds of fuel may not be usable for approach and landing.

111. True/False: One generator is insufficient to carry the total airplane electrical load.

112. The utility and emergency batteries will provide limited dc power for approximately . . . . . minutes.

113. True/False: Do not turn off any of the flight control systems in an attempt to conserve battery power.

114. Remaining battery life may be estimated as the U BATT LO light comes on when approximately . . . . percent of the total time remains (Airplanes 161353 thru 161528).

115. If the cabin temperature knob is full clockwise with the cabin temperature switch in MAN, cockpit temperature can reach as high as . . . . °F.

116. True/False: The most probable source of visible smoke or fumes in the cockpit is from the engine bleed or residual oil in the ECS ducts.

117. True/False: With both generators inoperative and good batteries your landing gear position indicator will function normally.

118. True/False: With both generators inoperative and good batteries your hydraulic pressure indicator will be inoperataive.

CONTINUED

119. True/False: Pressing the emergency jettison button, simultaneously jettisons stores from the parent bomb racks on external stores stations 2, 3, 5, 7, and 8.

120. True/False: Weight must be off the main landing gear or landing gear handle must be up for the emergency jettison system to be operational.

121. True/False: Failure of FCS channels 1 and 3 will not affect the flying qualities of the airplane.

122. True/False: With FLAPS OFF or FX GAINS caution, a reset of the system may cause the leading edge and or trailing edge flaps to retract.

123. True/False: If the trailing edge flaps are failed in the 0° position, final approach airspeed is not significantly affected.

124. True/False: A single–engine landing is made at HALF flaps.

125. With 1000 feet per minute sink rate, at 130 to 150 knots, with a 2–second reaction time, the minimum altitude for a successful ejection is . . . . . feet in the TF/A–18 at 0° angle of bank.

126. With 30° nose down and 90° angle of bank, the minimum altitude for a safe ejection is . . . . . feet in the F/A–18.

127. The correct procedure for an APU ACC caution airborne is:

128. List the steps for an out–of–control recovery.

129. Thunderstorm penetration should be made between optimum cruise and . . . . . knots below 35,000 feet, and no less than . . . . . knots above 35,000 feet.

130. What precautions must be observed when using the windshield rain removal?

1.
2.
3.
4.

131. the COM–NAV functions not available when MC 1 has failed are:

132. True/False: The right and left DDI's are physically and functionally interchangeable.

133. The bank angle scale pointer, on the HUD, is limited at . . . . and . . . . when the limit is exceeded.

134. The velocity vector represents:

135. True/False: Do not lock the gyro in the caged position with the pull to cage knob if the gyro is spinning.

Using Stall Speed chart:
Mil power
Gross weight – 28,000 pounds
Gear/flaps – DOWN

136. Determine – Stall Speed 0° Bank= . . . .

137. Determine – Stall Speed 45° Bank= . . . .

Using Landing Approach Speed chart:
Gross weight – 26,000 pounds
Flaps – 30°

138. Determine – Recommended Approach Speed= . . . .

CONTINUED

139. What action must the pilot take in order to slew the moving map with the TDC?

1.
2.

140. The GYRO position on the INS mode selector switch

a. Connects the gyros to the attitude heading reference system in order to complete an inflight alignment
b. Enables the mission computer to use the gyros in computations for air-to-air weapons delivery
c. Is the attitude mode where the INS operates only as an attitude heading reference system
d. All of the above

141. A maximum of . . . . . waypoints (do not count marks) can be stored in the mission computer.

142. REJ 1 removes what from the HUD display?

143. If you see the following in the upper left corner of the HI, what does it tell you?

237/108
18:00
NLC

a. Your aircraft is 108 miles from Lemoore TACAN on the 237° radial
b. Your aircraft is 108 miles from Lemoore TACAN on the 057° radial
c. Your aircraft is 18 miles from Lemoore TACAN on the 057° radial, 108° magnetic heading
d. Your aircraft is 18 miles from Lemoore TACAN on the 108° radial, 237° magnetic heading

144. During a data link ACLS (SPN–42) approach the HUD displays:

a. A TD box overlying the touchdown point
b. A fly–to tadpole symbol
c. Fly–to needles (similar to ILS)
d. A course arrow and elevation steering bar

145. True/False: During an ILS approach the standby attitude indicator displays the ILS needles.

146. What is the internal fuel capacity of the F/A–18: . . . . . pounds, TF/A–18: . . . . . . pounds.

147. State the following limitations:

Maximum steady state EGT –
Maximum start EGT –
Maximum EGT fluctuation (stabilized power) –
Maximum rpm fluctuation (stabilized power) –
Maximum transient rpm (N_2)
Maximum nozzle fluctuation

148. State the ranges for the following:

Ground idle rpm –
Flight idle rpm –
Maximum oil pressure (2¢ minutes after start with ambient temperature below –18°C, 0°F) Minimum oil pressure (ground idle) –
Inflight oil pressure:
Idle –
95% rpm –
Military –

CONTINUED

149. The maximum speeds of the following are:

Refueling probe –
Gear retraction/extension –
Gear emergency extension –
Trailing edge flaps –
Speedbrake (symmetrical flight) (5.3.1 PROM) –
Speedbrake (asymmetrical flight) (5.3.1 PROM) –
Arresting hook extension –
Canopy open –

150. State the following limitations:

Maximum gross weight field takeoff –
Maximum landing weight (field landing – flared) –
Maximum weight (touch and go)
  1. Single chamber strut –
  2. Dual chamber strut –
Maximum air refueling altitude –
Maximum closure on refueling drogue –
Maximum time at negative G –
Minimum time between negative G maneuvers –

151. If the velocity vector begins to flash slowly but is not HUD limited:

a. Selected ordnance has been released.
b. The mission computer may be displaying a degraded velocity vector
c. The waterline symbol is HUD limited
d. STBY attitude indicator is providing HUD attitude information

152. The HUD landing display (elongated horizon bar, AOA bracket, waterline symbol, steering display) will be presented

a. When selected through the HUD control panel
b. When selected on the right DDI (MFD)
c. When gear is down and NAV master mode is selected
d. Anytime that the gear is down

153. True/False: While using NAV Master Mode, the pilot has the option to cage or uncage the velocity vector on the HUD.

154. At what altitude will the cockpit begin to pressurize?

155. What action should be taken if FCS HOT caution light comes on in flight?

1.
2.

156. When the G XMT switch is placed to COMM 1 or COMM 2 the

a. Selected radio will receive/transmit on 243.0 only
b. Selected radio will receive only 243.0
c. Selected radio will transmit only 243.0

157. The hydraulic pumps are located on the . . . . and maintain the hydraulic pressure at approximately . . . . . . psi.

158. The HYD 2 priority valves close at approximately . . . . . psi.

159. Placing the EHSI/HSD mode selector switch to NORMAL displays compass rose aligned with the airplane

a. Magnetic ground track
b. Magnetic heading

CONTINUED

160. By what method is external tanks pressurized on the ground?

161. What indication does the pilot have to indicate low or lost motive flow pressure?

162. Fuel is transferred from external tanks by:

a. The passing of motive flow fuel through an ejector pump which utilizes the venturi principle to induce fuel flow.
b. Bleed air to pressurize each external tank.
c. Electrically powered boost pumps located inside each tank.
d. AMAD driven boost pumps that utilize the venturi principle to induce the flow from each tank.

163. True/False: In the TF/A-18 there is no provision to raise the landing gear from the rear cockpit.

164. With a failure of hydraulic system 2A, what alternate method exists for extending the air refueling probe?

165. Fuel dump is accomplished by:

a. Motive flow (ejector pumps)
b. Electrical pump powered by essential bus
c. AMAD driven boost pump
c. Variable displacements pumps driven by hydraulic system 2A

166. Normal brake system pressure is provided by hydraulic system . . . .

167. What optical indications of NWS failure will the pilot have available besides the MASTER CAUTION light?

1.
2.

168. What effect should be observed when the oxygen test button is pressed?

169. Where is the manual canopy crank located inside the F/A-18 cockpit?

170. Depending on airplane attitude and power setting, the fuel dump rate is about . . . . .pounds/minute.

171. True/False: Mechanical linkage will allow normal retraction of the nose gear even with the launch bar extended.

172. After emergency extension of the air refueling probe, how is the probe retracted? (With loss of 2A system)

173. What is the meaning of an OFF flag in the fuel gauge?

174. How many low fuel indications does the pilot receive? . . . . .
What are they?

175. Switching to RDR position on the HUD altitude switch will:

a. Cause radar altimeter information to be displayed at all times, until BARO is reselected.
b. Cause radar altimeter information to be displayed when at or below 5000 and valid.
c. Cause radar altimeter information to be displayed on the HUD while barometric altitude continues to be displayed on the DDI.
d. Cause radar altimeter information to be displayed just below the boxed barometric altitude display.

176. When data link information has been lost during an ACL mode 1 or 2 approach, the HUD indication will be:
a. TILT cue
b. Break X
c. Flashing velocity vector
d. Both a and b

177. While using the A/A master mode the velocity vector on the HUD will be:
a. Caged
b. Uncaged

CONTINUED

178. True/False: With an air–to–ground store or tank on a wing station, maximum roll rate is automatically reduced about 33%.

SECTION XI
PERFORMANCE DATA

PART 1 STANDARD DATA 11-3
PART 2 TAKEOFF 11-16
PART 3 CLIMB 11-30
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INTRODUCTION

This section is divided into parts (1 thru 10) to present performance data in proper sequence for preflight planning. All data are based on flight test or the contractor's estimate, U.S. standard day, 1962 conditions and/or provisions to correct for non-standard temperatures, and F404-GE-400 engines using JP-5 fuel.

GLOSSARY OF TERMS

Indicated Airspeed

Indicated airspeed (IAS) is the pitot static airspeed indicator reading, as installed in the aircraft, without correction for system errors.

Calibrated Airspeed

Calibrated airspeed (CAS) is indicated airspeed corrected for static source error.

Equivalent Airspeed

Equivalent airspeed (EAS) is calibrated airspeed corrected for adiabatic compressible flow for the particular altitude. EAS is equal to CAS at sea level in standard air.

True Airspeed

True Airspeed (TAS) is the aircraft speed over the ground in no-wind conditions. True airspeed is EAS corrected for density altitude.

Takeoff Speed

Takeoff speed is the speed at which the main gear lifts off the ground.

Nosewheel Lift-Off Speed

Nosewheel Lift-off speed is the speed at which the nosewheel lifts off the ground.

Pressure Altitude

Pressure Altitude is the vertical distance from the standard datum. This is a theoretical plane where air pressure (corrected to 15°C) is equal to 29.92 inches of mercury (Hg). The indicated pressure altitude may not be the actual height above sea level due to variations in temperature, lapse rate, atmospheric pressure, and errors on the sensed pressure.

Density Altitude

Density altitude is pressure altitude corrected for temperature. When conditions are standard, pressure altitude and density altitude are the same. Consequently, if the temperature is above standard, the density altitude will be higher than the pressure altitude. If the temperature is below standard, the density altitude will be lower than the pressure altitude.

Density Ratio

Density ratio is a single factor representation of a combination of temperature and pressure altitude.

Combat Ceiling

Combat ceiling is the altitude where the rate of climb is 500 feet per minute at either military (MIL) or maximum afterburner (MAX AB) rated power.

PART 1 - STANDARD DATA

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AIRSPEED CONVERSION CHART

The Airspeed Conversion chart (figure 11-3) provides a means of converting calibrated airspeed to true Mach number and true airspeed.

AIRSPEED POSITION ERROR CORRECTION CHART

Under normal conditions, airspeed position error is automatically compensated for by the air data computer system (ADC). However, if a malfunction of the ADC occurs, position error must be applied to the cockpit standby indication. This chart (figure 11-4) provides a direct-reading conversion from indicated airspeed to calibrated airspeed and from indicated Mach number to true Mach number.

Sample Problem

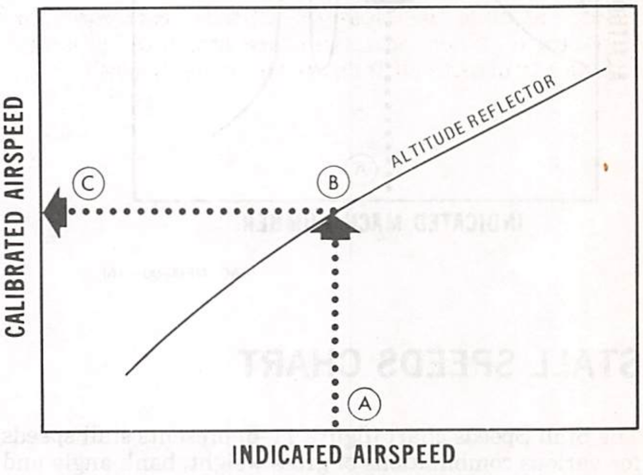
Indicated Airspeed

A. Indicated airspeed	500 Kt
B. Altitude	20,000 Ft
C. Calibrated airspeed	510 Kt

Mach Number

A. Indicated Mach number	1.0
B. Altitude reflector	
C. True Mach Number	1.07

SAMPLE AIRSPEED POSITION ERROR CORRECTION



18AC-NFM-00-(17)

ALTIMETER POSITION ERROR CORRECTION CHART

Under normal operating conditions, the air data computer (ADC) compensates for the static source position error. If the ADC fails in flight, the standby altimeter can be used. However, these readings must be corrected by means of the Altimeter Position Error Correction chart (figure 11-5). This chart provides altitude correction (ΔH) for indicated airspeeds up to 220 knots below 10,000 feet and for indicated Mach numbers up to 1.7 Mach at altitudes of sea level, 20,000 feet and 40,000 feet.

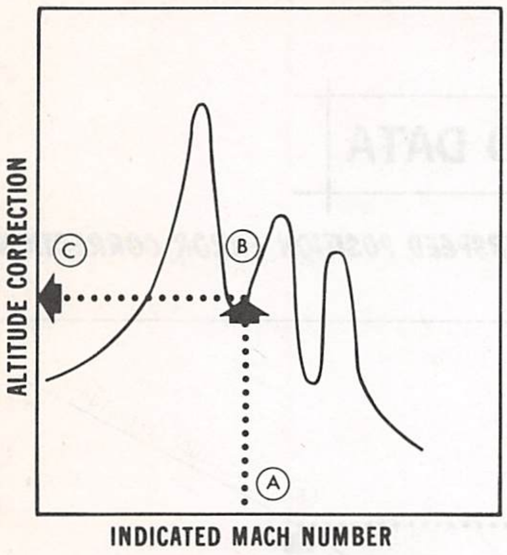
USE

Enter the applicable chart with the indicated Mach number or indicated airspeed. Project vertically upward to intercept the applicable altitude curve, then horizontally left to read the altitude correction (ΔH). Apply ΔH to the assigned altitude and fly assigned altitude +ΔH.

Sample Problem

A. Indicated Mach number	1.1
B. Assigned altitude	20,000 Ft
C. Altitude correction (ΔH)	-510 Ft
D. Assigned altitude +ΔH(B+C)	19,490 Ft

SAMPLE ALTIMETER POSITION ERROR CORRECTION



18AC–NFM–00–(16)

STALL SPEEDS CHART

The Stall Speeds chart (figure 11-6) presents stall speeds for various combinations of gross weight, bank angle and power setting at maximum lift. The data are based on catapult, approach, and maneuvering configurations.

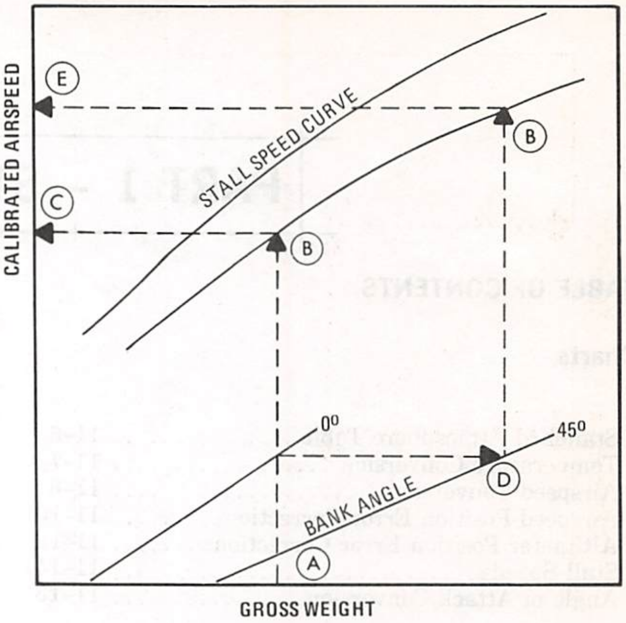
USE

Enter the chart with the applicable gross weight and project vertically up to intersect the zero degree bank angle. From this intersection, project horizontally right to the appropriate bank angle. From this point, project vertically up to the appropriate power setting curve, then horizontally left to read stall speed.

Sample Problem

A. Gross weight	35,000 Lb
B. Stall speed curve (MIL)	
C. Stall speed	106 Kt
D. Bank angle	45°
E. Stall speed	133 Kt

SAMPLE STALL SPEEDS



18AC–NFM–00–(15)

ANGLE OF ATTACK CONVERSION CHART

This chart (figure 11-7) presents the corresponding angle of attack in degrees for various combinations of calibrated airspeed and gross weight. The data are based on stabilized 1G level flight conditions with separate plots for 30° and 45° flap settings both with landing gear down.

USE

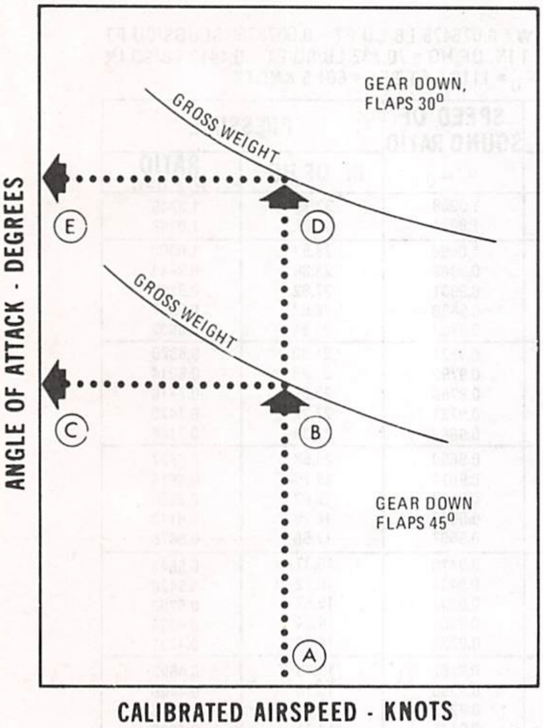
Enter the applicable plot at the airspeed scale and project vertically up to intersect the appropriate aircraft gross weight curve. From this intersection, project horizontally left to read the corresponding angle of attack for the specified flight condition/configuration.

Sample Problem

Configuration: Gear Down, Flaps 30°

A. Calibrated airspeed	160 Kt
B. Gross weight	35,000 Lb
C. Corresponding angle of attack	6.5°

SAMPLE ANGLE OF ATTACK CONVERSION



18AC–NFM–00–(14)

STANDARD ATMOSPHERE

STANDARD SEA LEVEL AIR:
T = 59°F (15°C)
P = 29.921 IN. OF HG

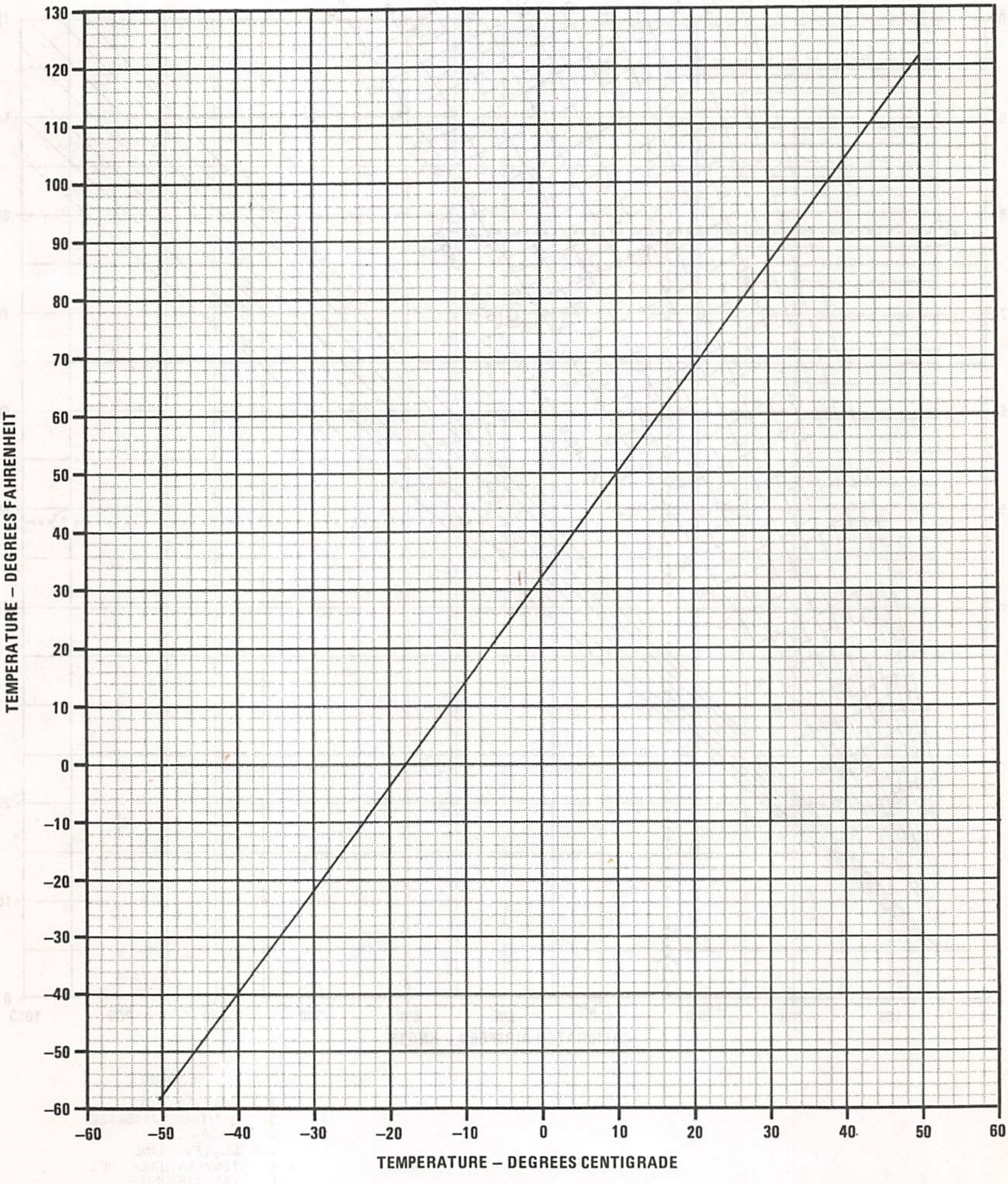
W = 0.076475 LB/CU FT = 0.0023769 SLUGS/CU FT
1 IN. OF HG = 70.732 LB/SQ FT = 0.4912 LB/SQ IN.
a_0 = 1116.5 FT/SEC = 661.5 KNOTS

ALTITUDE FEET	DENSITY RATIO $\rho/\rho_0 = \sigma$	$1/\sqrt{\sigma}$	AIR TEMPERATURE		SPEED OF SOUND RATIO a/a_0	PRESSURE	
			DEG. F	DEG. C		IN. OF HG	RATIO $\rho/\rho_0 = \delta$
-2,000	1.0598	0.9714	66.132	18.962	1.0068	32.15	1.0745
-1,000	1.0296	0.9855	62.566	16.981	1.0034	31.02	1.0368
0	1.0000	1.0000	59.000	15.000	1.0000	29.92	1.0000
1,000	0.9711	1.0148	55.434	13.019	0.9966	28.86	0.9644
2,000	0.9428	1.0299	51.868	11.038	0.9931	27.82	0.9298
3,000	0.9151	1.0454	48.302	9.057	0.9896	26.82	0.8962
4,000	0.8881	1.0611	44.735	7.075	0.9862	25.84	0.8637
5,000	0.8617	1.0773	41.169	5.094	0.9827	24.90	0.8320
6,000	0.8359	1.0938	37.603	3.113	0.9792	23.98	0.8014
7,000	0.8106	1.1107	34.037	1.132	0.9756	23.09	0.7716
8,000	0.7860	1.1279	30.471	-0.849	0.9721	22.22	0.7428
9,000	0.7620	1.1456	26.905	-2.831	0.9686	21.39	0.7148
10,000	0.7385	1.1637	23.338	-4.812	0.9650	20.58	0.6877
11,000	0.7156	1.1822	19.772	-6.793	0.9614	19.79	0.6614
12,000	0.6932	1.2011	16.206	-8.774	0.9579	19.03	0.6360
13,000	0.6713	1.2205	12.640	-10.756	0.9543	18.29	0.6113
14,000	0.6500	1.2403	9.074	-12.737	0.9507	17.58	0.5875
15,000	0.6292	1.2606	5.508	-14.718	0.9470	16.87	0.5643
16,000	0.6090	1.2815	1.941	-16.699	0.9434	16.22	0.5420
17,000	0.5892	1.3028	-1.625	-18.681	0.9397	15.57	0.5203
18,000	0.5699	1.3246	-5.191	-20.662	0.9361	14.94	0.4994
19,000	0.5511	1.3470	-8.757	-22.643	0.9324	14.34	0.4791
20,000	0.5328	1.3700	-12.323	-24.624	0.9287	13.75	0.4593
21,000	0.5150	1.3935	-15.889	-26.605	0.9250	13.18	0.4406
22,000	0.4976	1.4176	-19.456	-28.587	0.9213	12.64	0.4223
23,000	0.4807	1.4424	-23.022	-30.568	0.9175	12.11	0.4046
24,000	0.4642	1.4678	-26.588	-32.549	0.9138	11.60	0.3876
25,000	0.4481	1.4938	-30.154	-34.530	0.9100	11.10	0.3711
26,000	0.4325	1.5206	-33.720	-36.511	0.9062	10.63	0.3552
27,000	0.4173	1.5480	-37.286	-38.492	0.9024	10.17	0.3398
28,000	0.4025	1.5762	-40.852	-40.473	0.8986	9.725	0.3250
29,000	0.3881	1.6052	-44.419	-42.455	0.8948	9.297	0.3107
30,000	0.3741	1.6349	-47.985	-44.436	0.8909	8.885	0.2970
31,000	0.3605	1.6654	-51.551	-46.417	0.8871	8.488	0.2837
32,000	0.3473	1.6968	-55.117	-48.398	0.8832	8.106	0.2709
33,000	0.3345	1.7291	-58.683	-50.379	0.8793	7.737	0.2586
34,000	0.3220	1.7623	-62.249	-52.361	0.8754	7.382	0.2467
35,000	0.3099	1.7964	-65.816	-54.342	0.8714	7.041	0.2353
36,000	0.2981	1.8315	-69.382	-56.323	0.8675	6.712	0.2243
37,000	0.2844	1.8753	-69.700	-56.500	0.8671	6.397	0.2138
38,000	0.2710	1.9209	-69.700	-56.500	0.8671	6.097	0.2038
39,000	0.2583	1.9677	-69.700	-56.500	0.8671	5.811	0.1942
40,000	0.2462	2.0155	-69.700	-56.400	0.8671	5.538	0.1851
41,000	0.2346	2.0645	-69.700	-56.500	0.8671	5.278	0.1764
42,000	0.2236	2.1148	-69.700	-56.500	0.8671	5.030	0.1681
43,000	0.2131	2.1662	-69.700	-56.500	0.8671	4.794	0.1602
44,000	0.2031	2.2189	-69.700	-56.500	0.8671	4.569	0.1527
45,000	0.1936	2.2728	-69.700	-56.500	0.8671	4.355	0.1455
46,000	0.1845	2.3281	-69.700	-56.500	0.8671	4.151	0.1387
47,000	0.1758	2.3848	-69.700	-56.500	0.8671	3.956	0.1322
48,000	0.1676	2.4428	-69.700	-56.500	0.8671	3.770	0.1260
49,000	0.1597	2.5022	-69.700	-56.500	0.8671	3.593	0.1201
50,000	0.1522	2.5630	-69.700	-56.500	0.8671	3.425	0.1145
51,000	0.1451	2.6254	-69.700	-56.500	0.8671	3.264	0.1091
52,000	0.1383	2.6892	-69.700	-56.500	0.8671	3.111	0.1040
53,000	0.1318	2.7546	-69.700	-56.500	0.8671	2.965	0.09909
54,000	0.1256	2.8216	-69.700	-56.500	0.8671	2.826	0.09444
55,000	0.1197	2.8903	-69.700	-56.500	0.8671	2.693	0.09001
56,000	1.1141	2.9606	-69.700	-56.500	0.8671	2.567	0.08578
57,000	0.1087	3.0326	-69.700	-56.500	0.8671	2.446	0.08176
58,000	0.1036	3.1063	-69.700	-56.500	0.8671	2.331	0.07792
59,000	0.09877	3.1819	-69.700	-56.500	0.8671	2.222	0.07426
60,000	0.09414	3.2593	-69.700	-56.500	0.8671	2.118	0.07078
61,000	0.08972	3.3386	-69.700	-56.500	0.8671	2.018	0.06746
62,000	0.08551	3.4198	-69.700	-56.500	0.8671	1.924	0.06429
63,000	0.08150	3.5029	-69.700	-56.500	0.8671	1.833	0.06127
64,000	0.07767	3.5881	-69.700	-56.500	0.8671	1.747	0.05840
65,000	0.07403	3.6754	-69.700	-56.500	0.8671	1.665	0.05566

18AC–NFM–00–(22)

Figure 11–1. Standard Atmosphere

TEMPERATURE CONVERSION

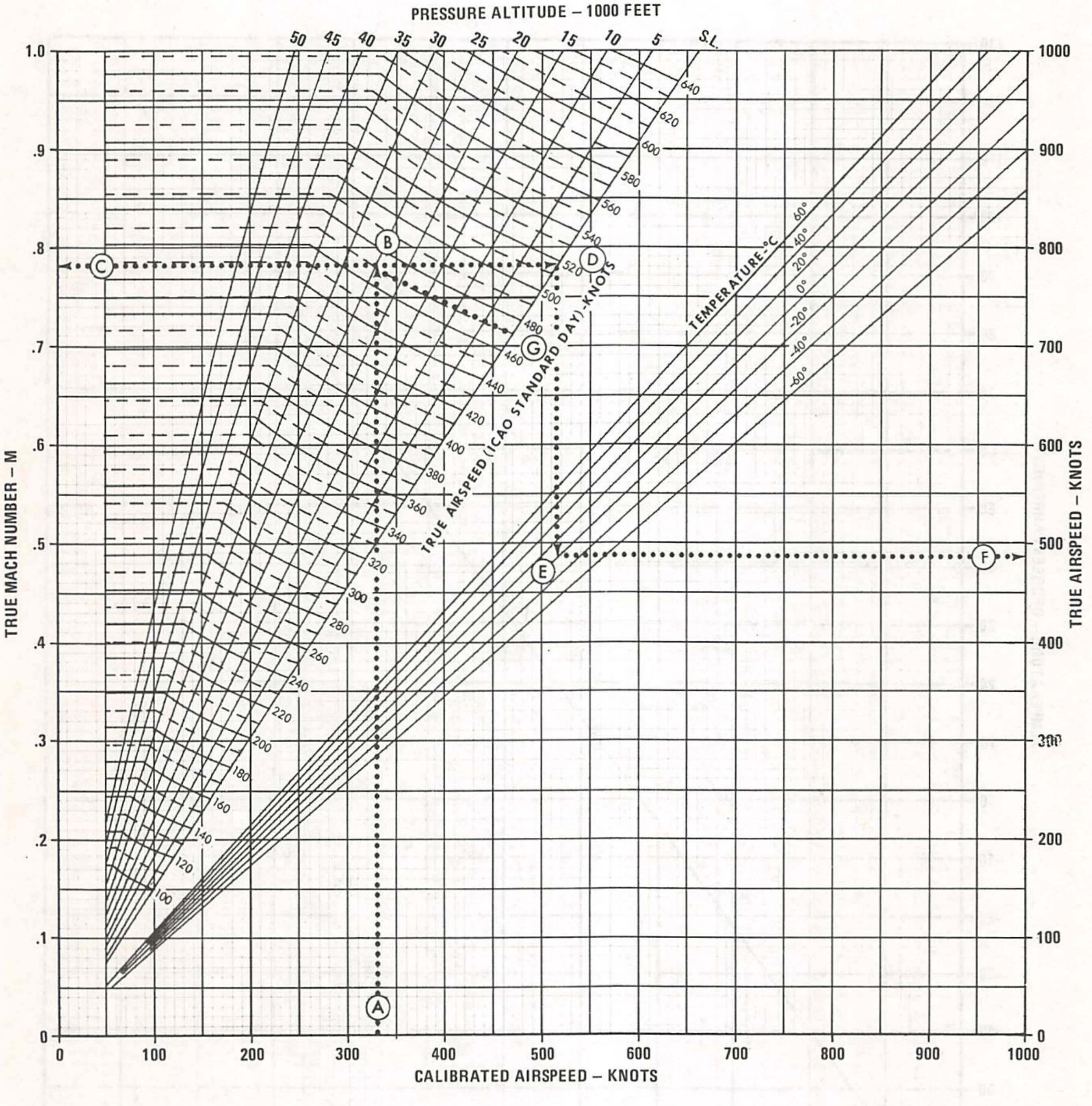


18AC–NFM–00–(31)

Figure 11–2. Temperature Conversion

AIRSPEED CONVERSION

LOW MACH



EXAMPLE

A = CAS = 330 KNOTS
B = ALTITUDE = 25,000 FEET
C = MACH = .782
D = SEA LEVEL LINE
E = TEMPERATURE = −20°C
F = TAS = 486 KNOTS
G = TAS (STANDARD DAY) = 472 KNOTS

18AC–NFM–00–(29–1)

Figure 11-3. Airspeed Conversion – Low Mach (Sheet 1 of 2)

AIRSPEED CONVERSION

HIGH MACH

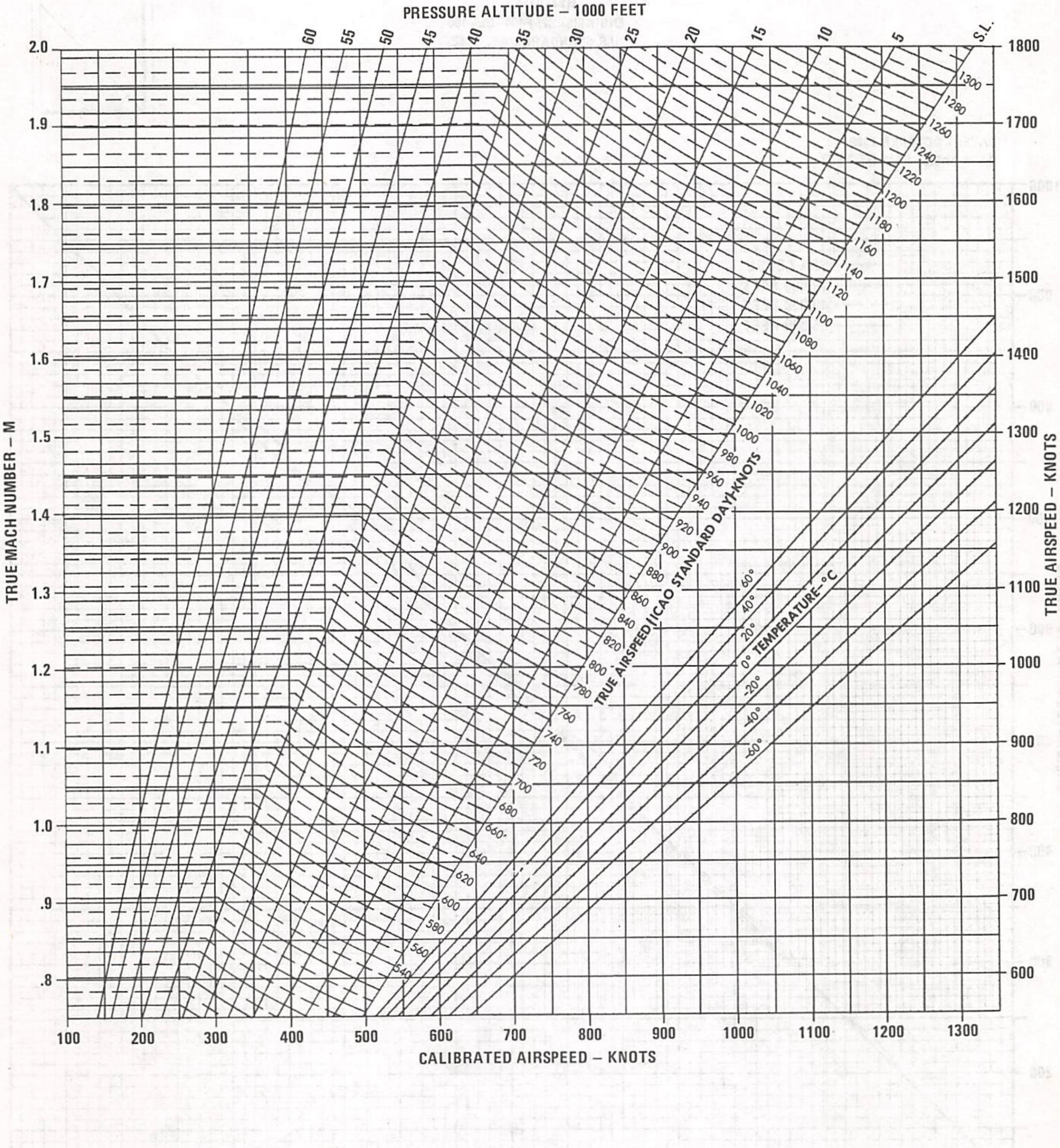


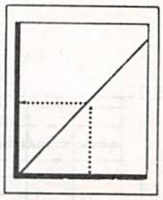
Figure 11-3. Airspeed Conversion – High Mach (Sheet 2)

AIRSPEED POSITION ERROR CORRECTION

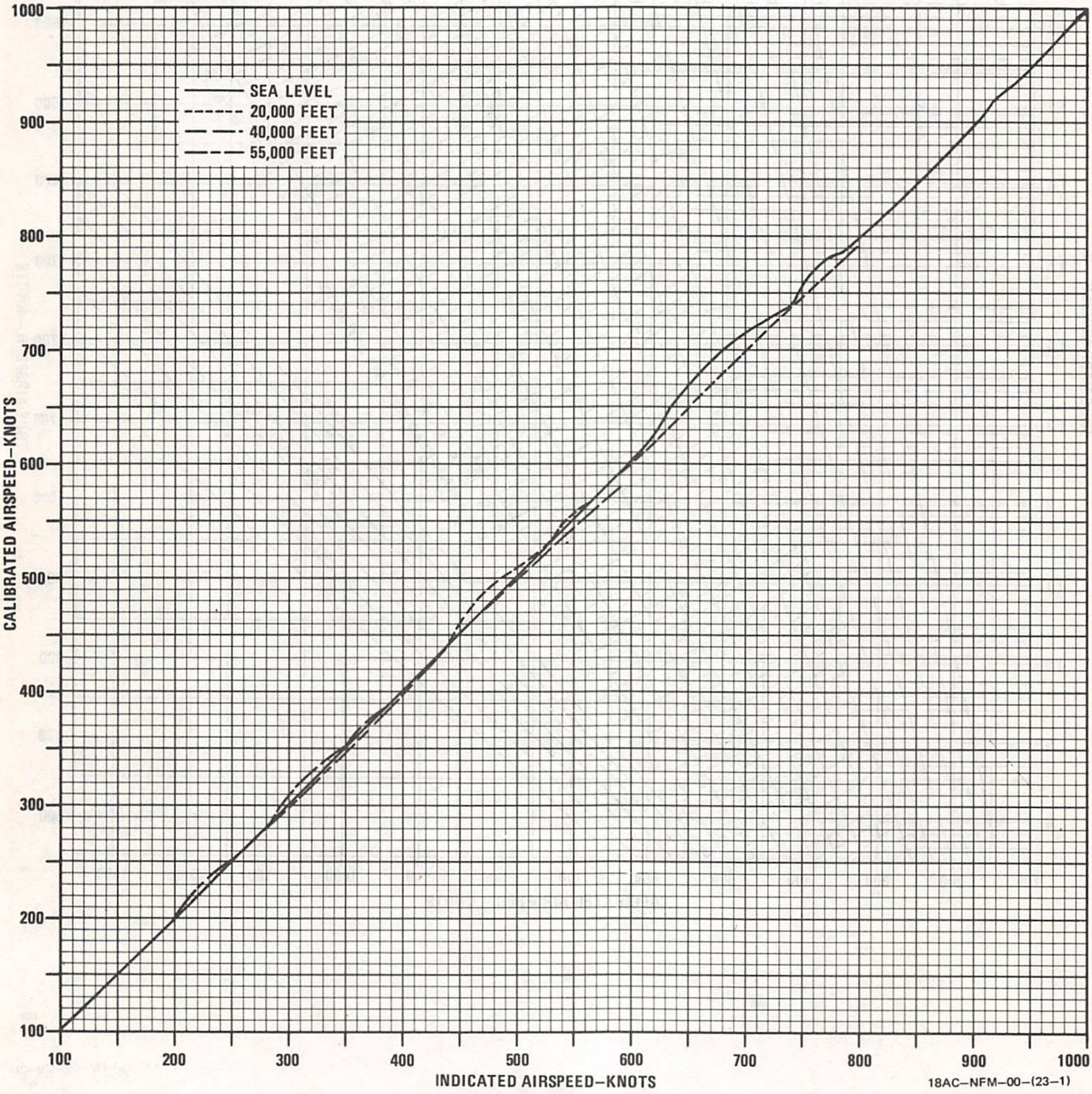
INDICATED AIRSPEED-STANDBY INDICATOR
ALL CONFIGURATIONS

REMARKS
ENGINE(S): (2) F404–GE–400
U.S. STANDARD DAY, 1962

GUIDE



DATE: 1 OCTOBER 1980
DATA BASIS: **FLIGHT TEST**



18AC–NFM–00–(23–1)

Figure 11-4. Airspeed Position Error Correction – Indicated Airspeed (Sheet 1 of 2)

AIRSPEED POSITION ERROR CORRECTION

MACH NUMBER-STANDBY INDICATOR
ALL CONFIGURATIONS

REMARKS
ENGINE(S): (2)F404–GE–400
U.S. STANDARD DAY, 1962

DATE: 1 OCTOBER 1980
DATA BASIS: **FLIGHT TEST**

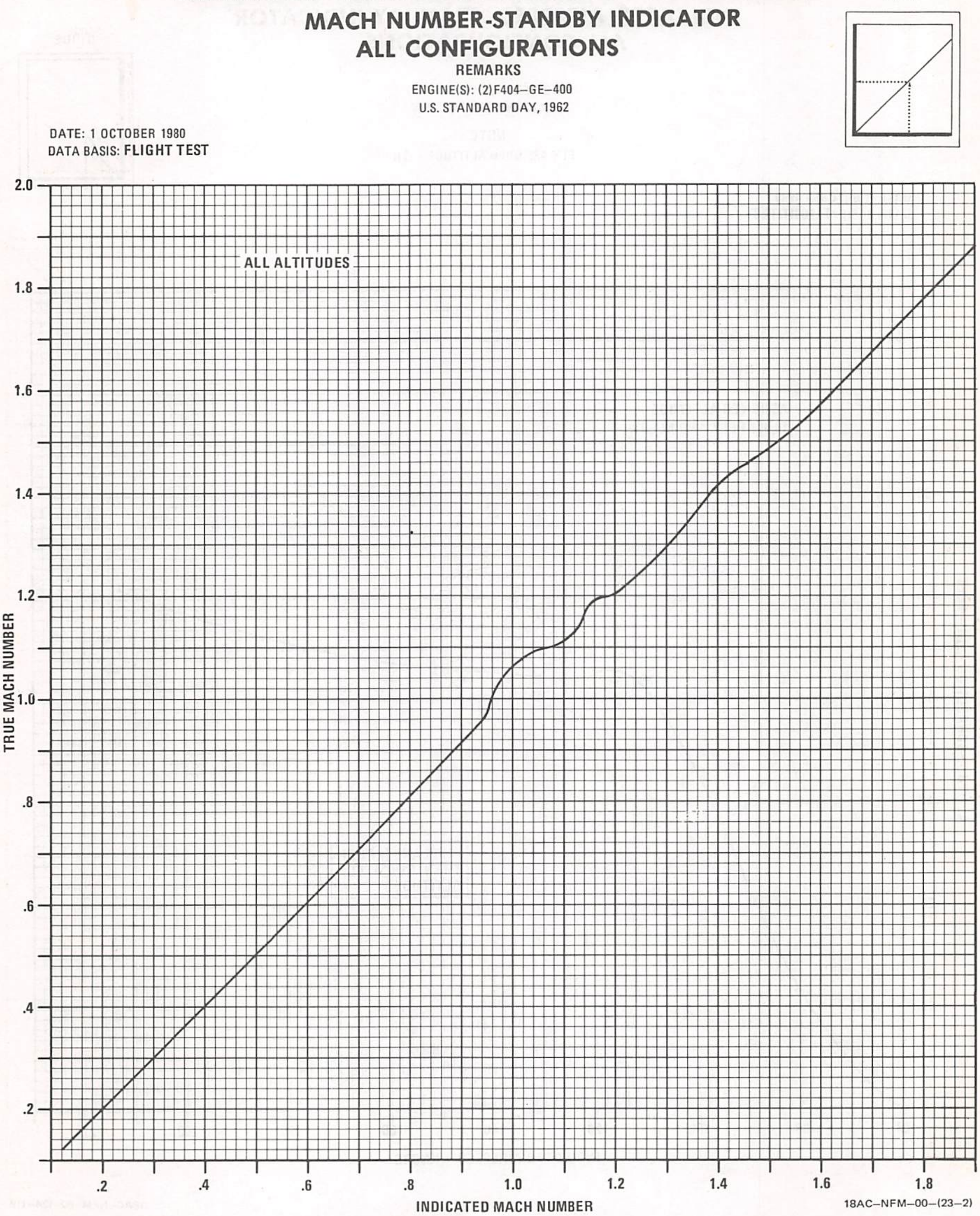


Figure 11–4. Airspeed Position Error Correction – Mach Number (Sheet 2)

ALTIMETER POSITION ERROR CORRECTION

INDICATED AIRSPEED- STANDBY INDICATOR
ALL CONFIGURATIONS

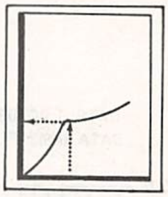
REMARKS

ENGINE(S): (2)F404-GE-400
U. S. STANDARD DAY, 1962

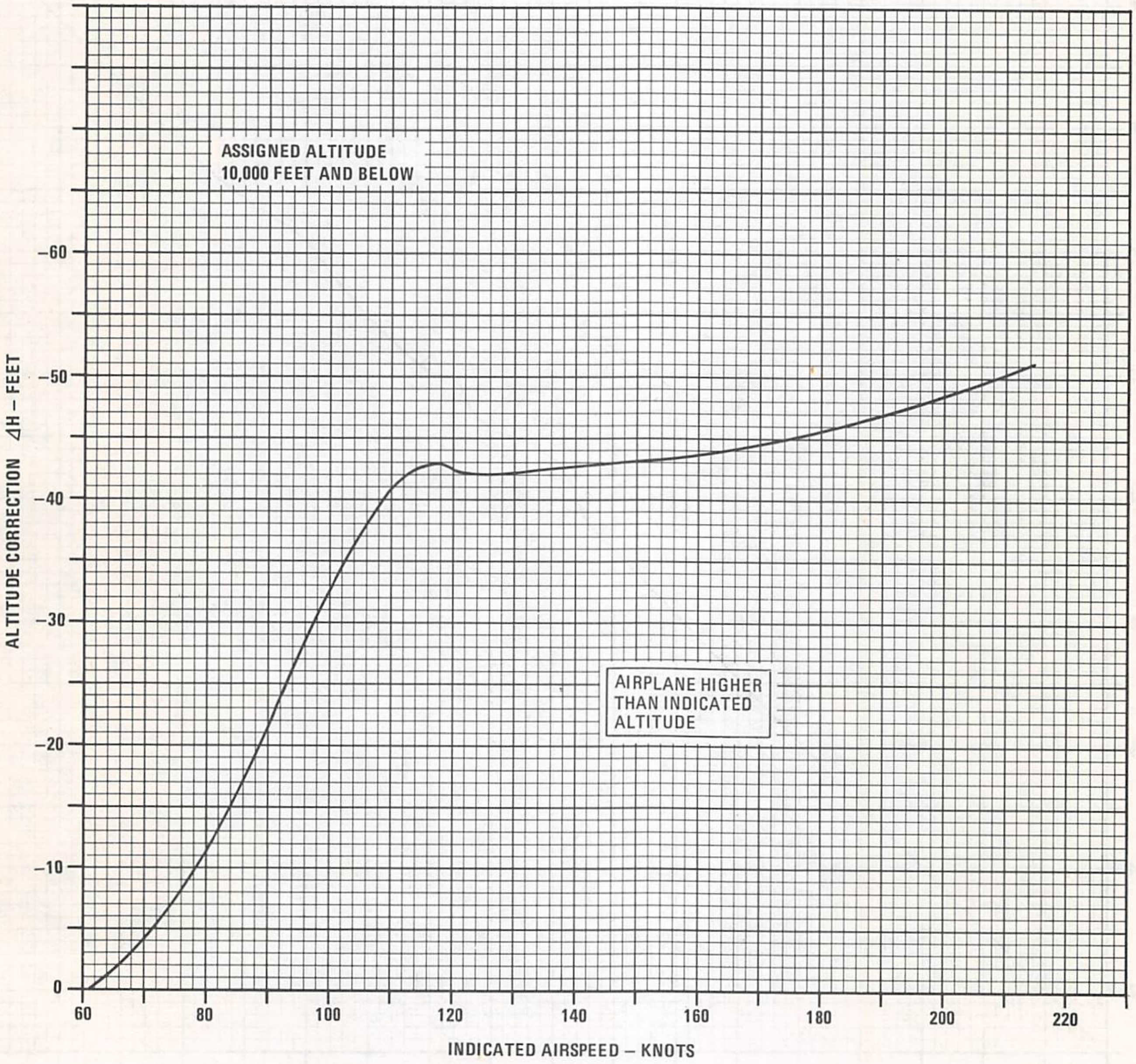
NOTE

FLY ASSIGNED ALTITUDE + ΔH

GUIDE



DATE: 1 OCTOBER 1980
DATA BASIS: **FLIGHT TEST**



18AC–NFM–00–(24–1)B

Figure 11–5. Altimeter Position Error Correction – Indicated Airspeed (Sheet 1 of 2)

ALTIMETER POSITION ERROR CORRECTION

MACH NUMBER-STANDBY INDICATOR
ALL CONFIGURATIONS

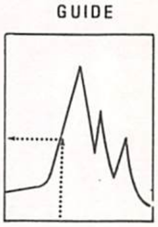
REMARKS

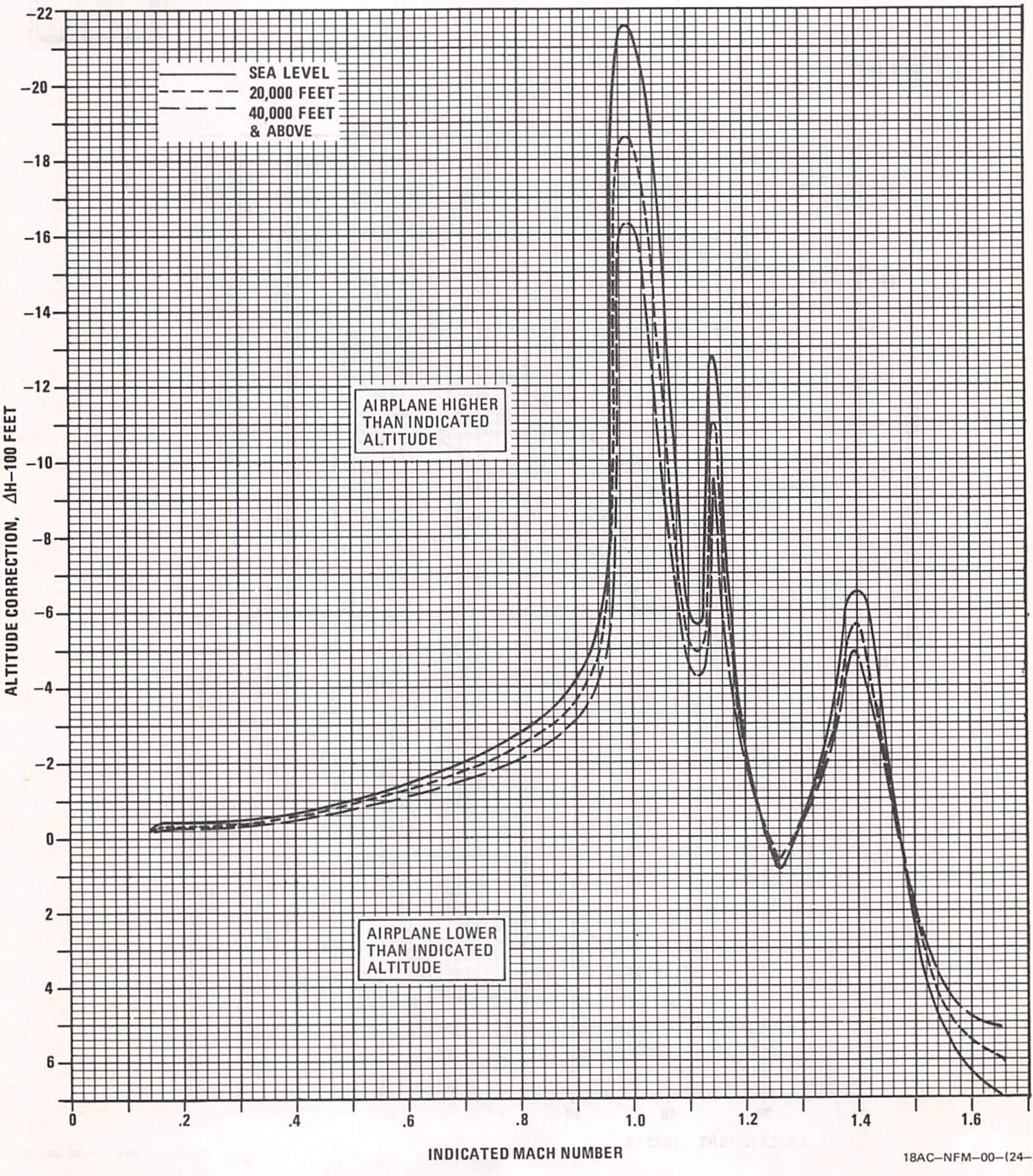
ENGINE(S): (2) F404-GE-400
U. S. STANDARD DAY, 1962

DATE: 1 OCTOBER 1980
DATA BASIS: **FLIGHT TEST**

NOTE

FLY ASSIGNED ALTITUDE + ΔH





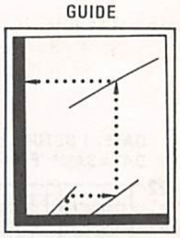
18AC–NFM–00–(24–2)B

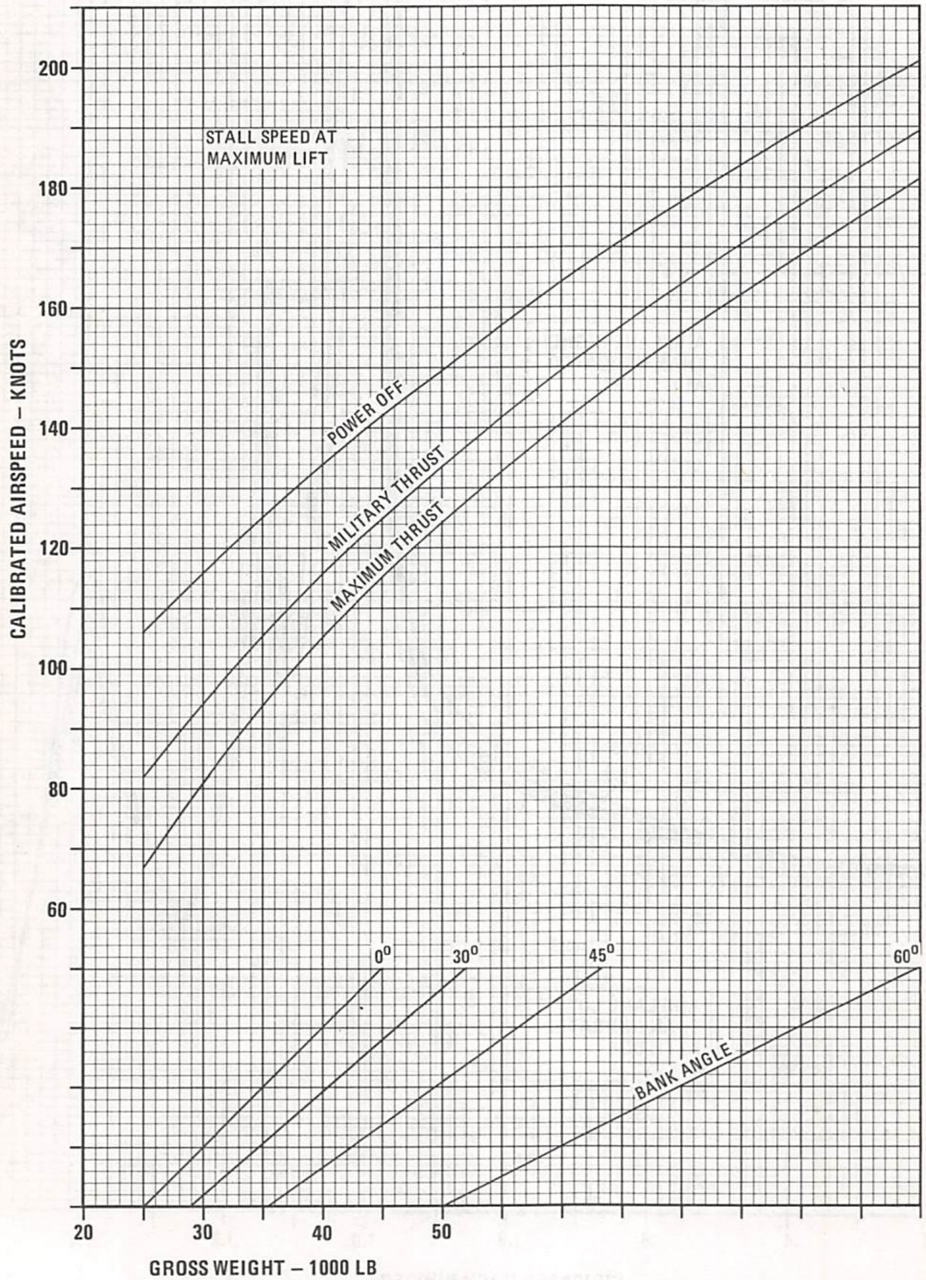
Figure 11-5. Altimeter Position Error Correction – Mach Number (Sheet 2)

STALL SPEEDS
ALL CONFIGURATIONS

REMARKS
ENGINES (S): (2) F404–GE–400
U. S. STANDARD DAY, 1962

DATE: 3 MARCH 1981
DATA BASIS: **FLIGHT TEST**





18AC–NFM–00–(25)A

Figure 11-6. Stall Speeds

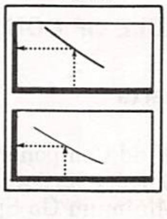
ANGLE OF ATTACK CONVERSION

STABILIZED IG LEVEL FLIGHT

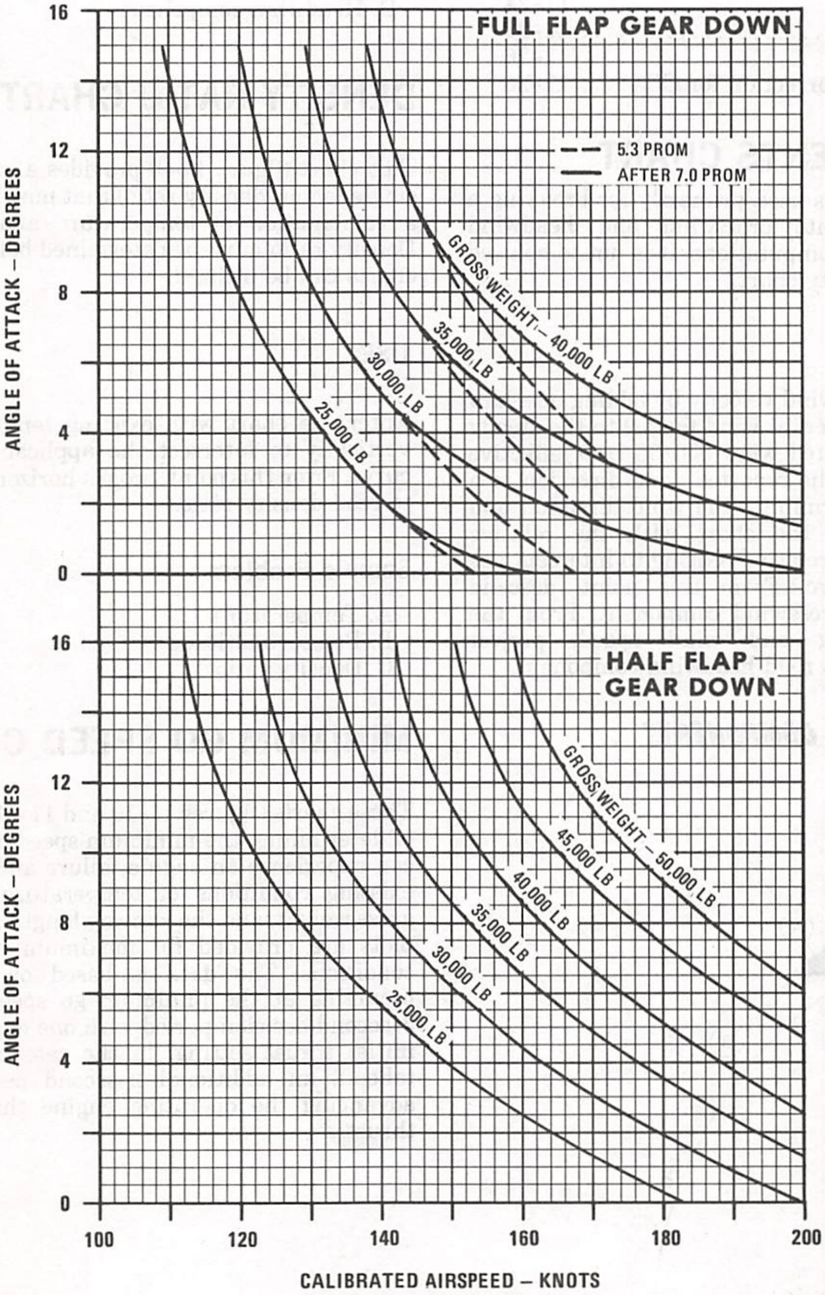
AIRPLANE CONFIGURATION
GEAR AND FLAPS
AS NOTED

REMARKS
ENGINE (S) F404 – GE – 400
U. S. STANDARD DAY, 1962
SEA LEVEL – CG 25% MAC

GUIDE



DATE: 1 MARCH 1983
DATA BASIS: **FLIGHT TEST**



18AC NFM-00-(26)B

Figure 11-7. Angle of Attack Conversion

PART 2 - TAKEOFF

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Maximum Go Speed........................ 11-24
Maximum Abort Speed..................... 11-25
Takeoff Distance.......................... 11-26
Takeoff Ground Roll Correction for CG 11-28

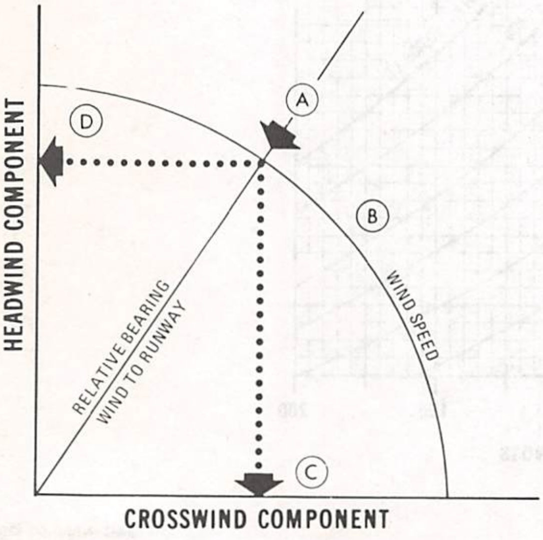
WIND COMPONENTS CHART

This chart (figure 11-8) is used primarily for breaking a forecast wind down into crosswind and headwind components for takeoff computations. It is not to be used as a ground controllability chart.

USE

Determine the effective wind velocity by adding one-half the gust velocity (incremental wind factor) to the steady state velocity; e.g., reported wind 050/30 G40, effective wind is 050/35. Reduce the reported wind direction to a relative bearing by determining the wind direction and runway heading. Enter the chart with the relative bearing. Move along the relative bearing to intercept the effective wind speed arc. From this point, descend vertically to read the crosswind component. From the intersection of bearing and wind speed, project horizontally to the left to read headwind component.

SAMPLE WIND COMPONENTS



18AC-NFM-00-(18)

Sample Problem

Reported wind 050/35, runway heading 030.

A. Relative bearing	20°
B. Intersect windspeed arc	35 Kt
C. Crosswind component	12 Kt
D. Headwind component	33 Kt

DENSITY RATIO CHART

This chart (figure 11-9) provides a means of obtaining a single factor (density ratio) that may be used to represent a combination of temperature and pressure altitude. Density ratio must be determined before the takeoff data charts can be utilized.

USE

Enter the chart with existing temperature and project vertically to intersect the applicable pressure altitude curve. From this point, project horizontally to the left scale to read density ratio.

Sample Problem

A. Temperature	60°F
B. Pressure altitude	2000 Ft
C. Density ratio	0.93

MINIMUM GO SPEED CHART

These charts (figures 11-10 and 11-11) provide the means of determining the minimum speed at which the aircraft can experience an engine failure and still take off under existing conditions of temperature, pressure altitude, gross weight, and the runway length remaining. Separate plots are provided for maximum and military thrust conditions. The data is based on an engine failure occurring at the minimum go speed and allows for a 3-second decision period with one engine operating at its initial thrust setting. In the case of a military thrust takeoff, an additional 2-second period is allowed for advancing the operating engine throttle to maximum thrust.

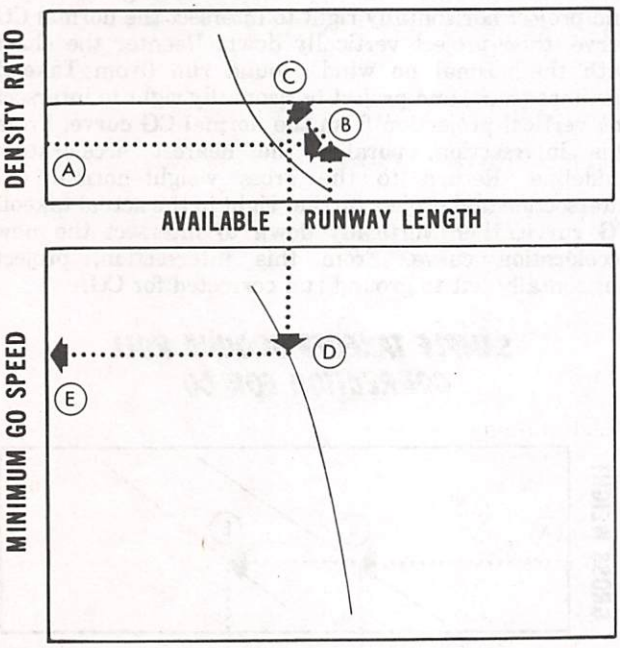
WARNING

If an engine is lost above the maximum abort speed but below the minimum go speed, the pilot can neither abort nor take off safely on the runway length remaining without considering such factors as reducing gross weight or engaging the overrun end arrestment cable.

USE

Enter the applicable plot with the prevailing density ratio, and project horizontally to the available runway length grid line. Parallel the nearest guideline up or down to intersect the baseline. From this point descend vertically to intersect the applicable takeoff gross weight curve, then horizontally to read minimum go speed. If this projected line does not intersect the computed takeoff gross weight curve, then there will be no corresponding minimum go speed. If the gross weight curve lies to the right of the projected line, a single–engine takeoff cannot be made under the combined conditions.

SAMPLE MINIMUM GO SPEED



18AC–NFM–00–(103)

Sample Problem

Maximum Thrust Takeoff

A. Density ratio	0.90
B. Available runway length	8000 Ft
C. Parallel guideline to baseline	
D. Takeoff gross weight	50,000 Lb
E. Minimum go speed	141 KCAS

NOTE

This problem assumes maximum thrust on operating engine within 5 seconds after engine failure. The minimum go speed for a maximum thrust takeoff will be less than that for a military thrust takeoff due to the greater acceleration with maximum thrust up to and including the 3-second decision time.

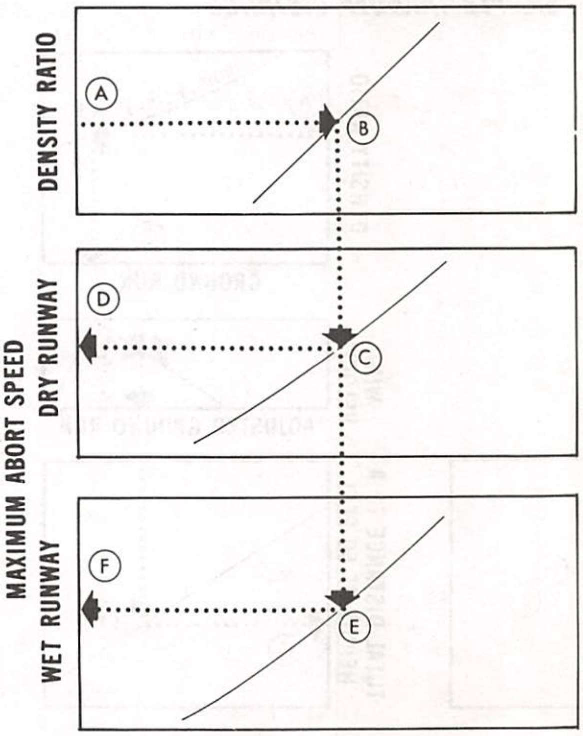
MAXIMUM ABORT SPEED CHART

These charts (figures 11–12 and 11–13) provide a means of determining the maximum speed at which an abort may be started and the aircraft stopped within the remaining runway length. Separate charts are provided for maximum and military thrust and various takeoff gross weights on both dry and wet runways. The data are based on a 3–second reaction time after engine failure followed by a 2–second transition time to reach idle thrust and full braking (brake limits applied)..

USE

Enter the chart with the prevailing density ratio and project horizontally right to intersect the available runway length curve. From this point, project vertically down to the applicable gross weight curve for either dry or wet runway conditions, then horizontally left to read maximum abort speed.

SAMPLE MAXIMUM ABORT SPEED



18AC–NFM–00–(98)

Sample Problem

Maximum Thrust Takeoff, Dry Runway

A. Density ratio	0.90
B. Available runway length	8000 Ft
C. Gross weight	45,000 Lb
D. Maximum abort speed	122 KCAS

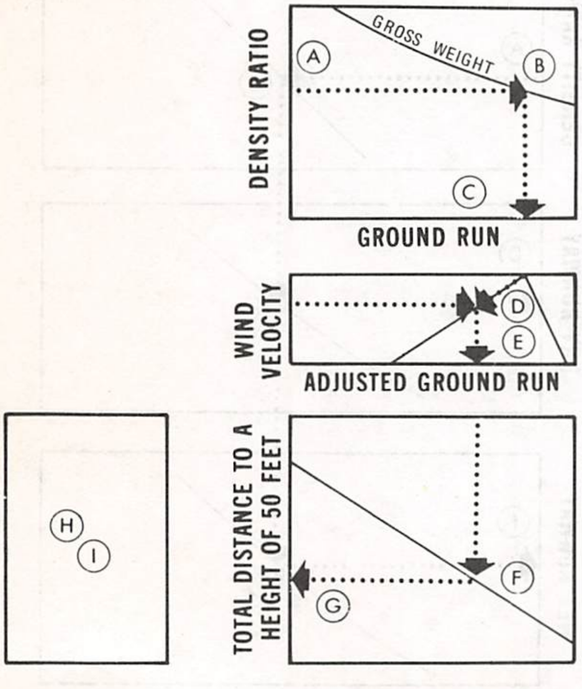
TAKEOFF DISTANCE CHARTS

These charts (figures 11-14 and 11-15) are used to determine the no wind ground run distance, wind adjusted ground run and the total distance to climb to a height of 50 feet. Separate charts are provided for maximum and military thrust. A table has been provided on each chart to show nosewheel liftoff speed with the corresponding aircraft takeoff speed for various gross weight and CG combinations.

USE

Enter the chart with the applicable density ratio and project horizontally right to intersect the appropriate takeoff gross weight curve. From this intersection, project vertically down to read no wind ground run distance. Parallel the appropriate wind guideline (headwind or tailwind) to intersect the takeoff wind velocity. From this point project vertically down to read ground run adjusted for wind effects. To find the total distance required to climb to a height of 50 feet, continue down to the reflector line and project horizontally to the left scale.

SAMPLE TAKEOFF DISTANCE



18AC-NFM-00-(19)

Sample Problem

Maximum Thrust, Takeoff CG - 22% MAC

A. Density ratio	0.90
B. Gross weight	40,000 Lb
C. No wind ground run distance	2400 Ft
D. Effective headwind	10 Kt
E. Ground run (wind corrected)	2200 Ft
F. Total distance required to climb to a height of 50 feet	3250 Ft
G. Nosewheel liftoff speed for a CG of 22% MAC (from table)	144 Kt
H. Takeoff speed (from table)	158 Kt

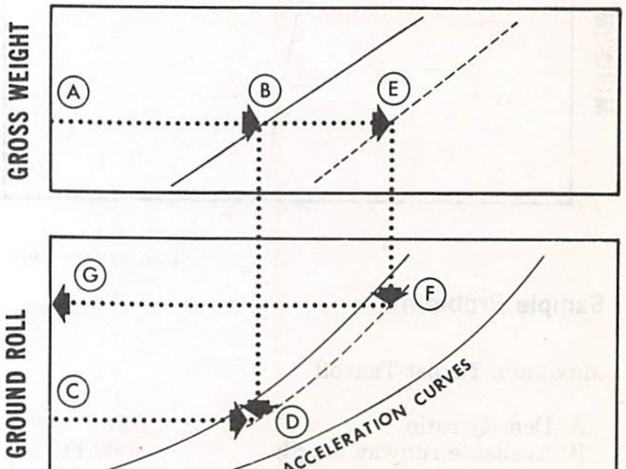
TAKEOFF GROUND ROLL CORRECTION FOR CG

These charts (figures 11-16 and 11-17) are used primarily to determine takeoff distances resulting from adverse conditions of gross weight and CG. The charts can also be used to obtain any distance and speed relationship during the takeoff ground run.

USE

Enter the chart with the applicable takeoff gross weight and project horizontally right to intersect the normal CG curve, then project vertically down. Reenter the chart with the normal no wind ground run (from Takeoff Distance chart) and project horizontally right to intersect the vertical projection from the normal CG curve. From this intersection, parallel the nearest acceleration guideline. Return to the gross weight-normal CG intersection and project further right to the actual takeoff CG curve, then vertically down to intersect the new acceleration curve. From this intersection, project horizontally left to ground run corrected for CG.

SAMPLE TAKEOFF GROUND ROLL CORRECTION FOR CG



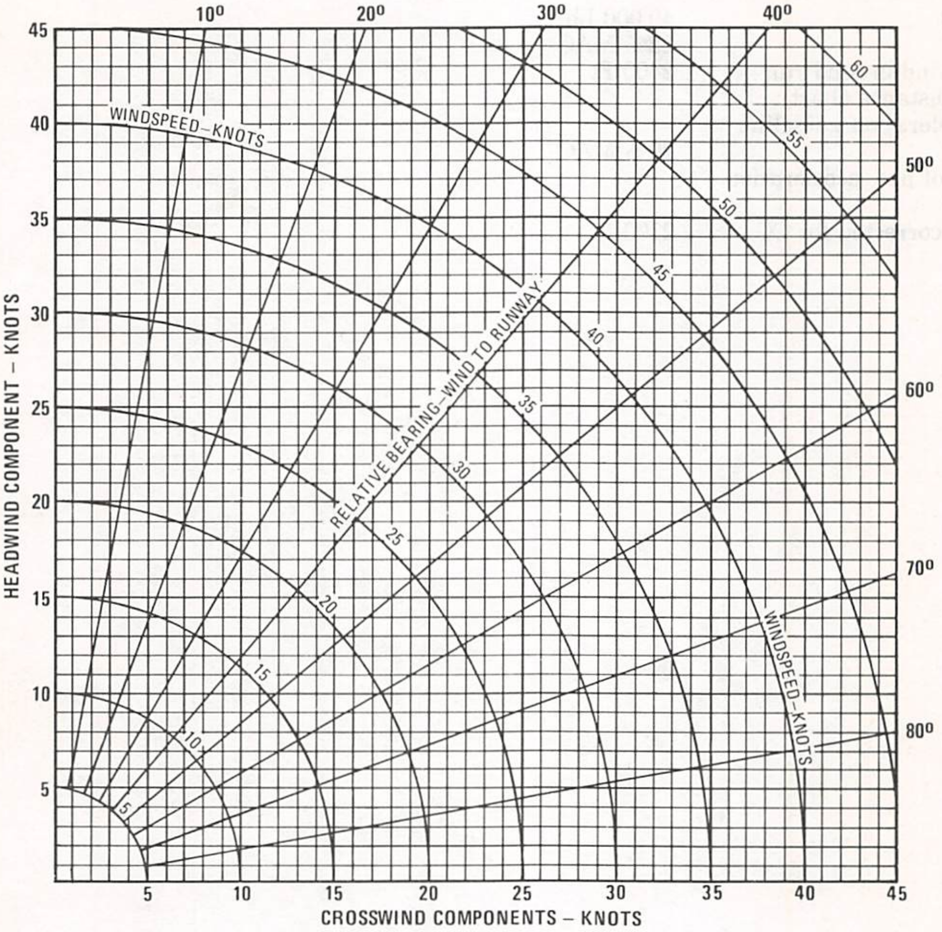
18AC-NFM-00-(104)

Sample Problem

Maximum Thrust, Takeoff CG 20% MAC

A. Gross weight	40,000 Lb
B. Normal CG	22% MAC
C. Normal no wind ground run (from Takeoff Distance chart)	2400 Ft
D. Parallel acceleration guideline	
E. Takeoff CG	20% MAC
F. Intersection of new acceleration curve	
G. Ground run corrected for CG	2700 Ft

WIND COMPONENTS



18AC–NFM–00–(30)

Figure 11—8. Wind Components

DENSITY RATIO

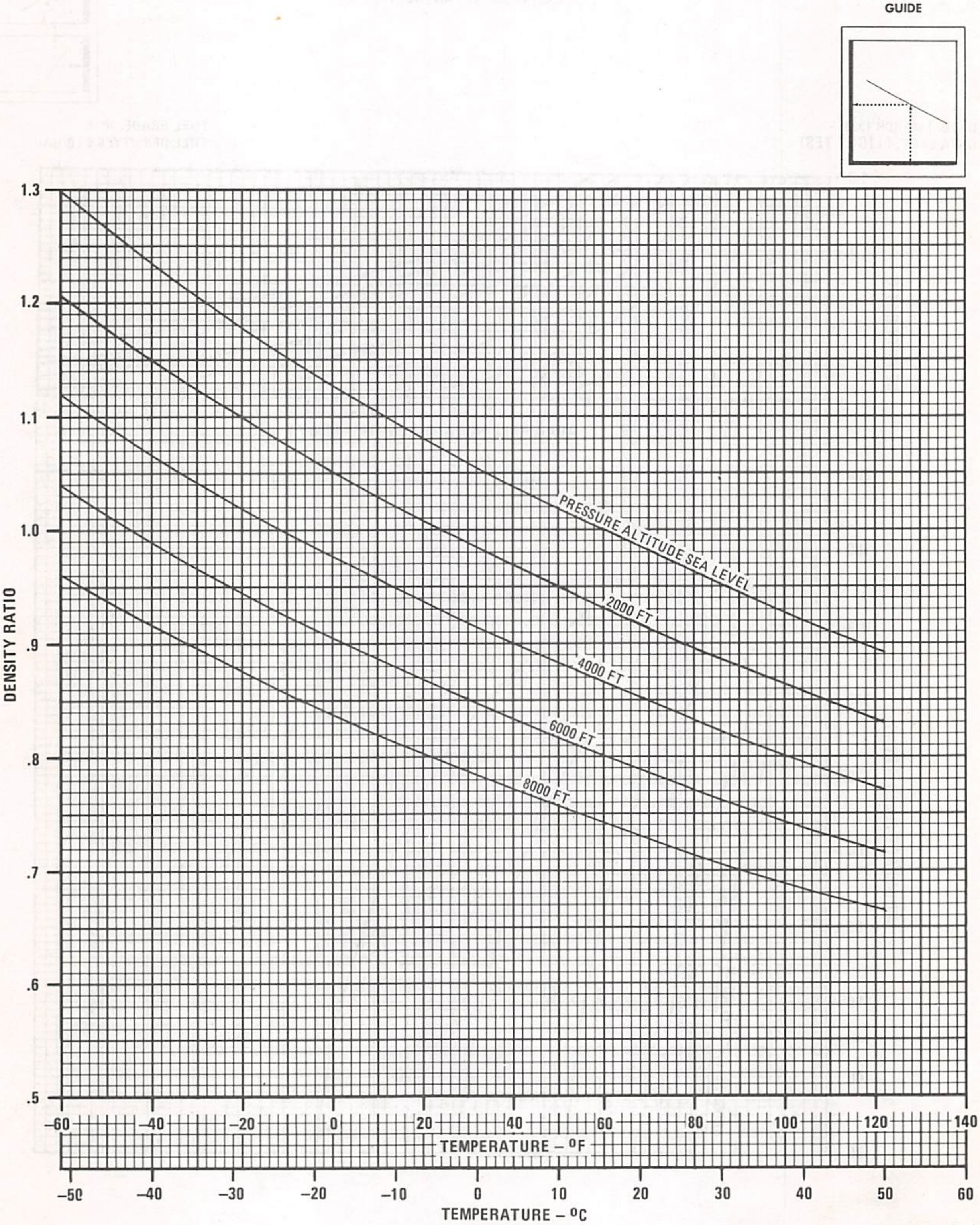


Figure 11-9. Density Ratio

MINIMUM GO SPEED
MAXIMUM THRUST
HARD DRY RUNWAY

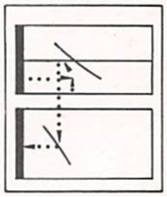
AIR PLANE CONFIGURATION
T. E. FLAPS 30°
GEAR DOWN

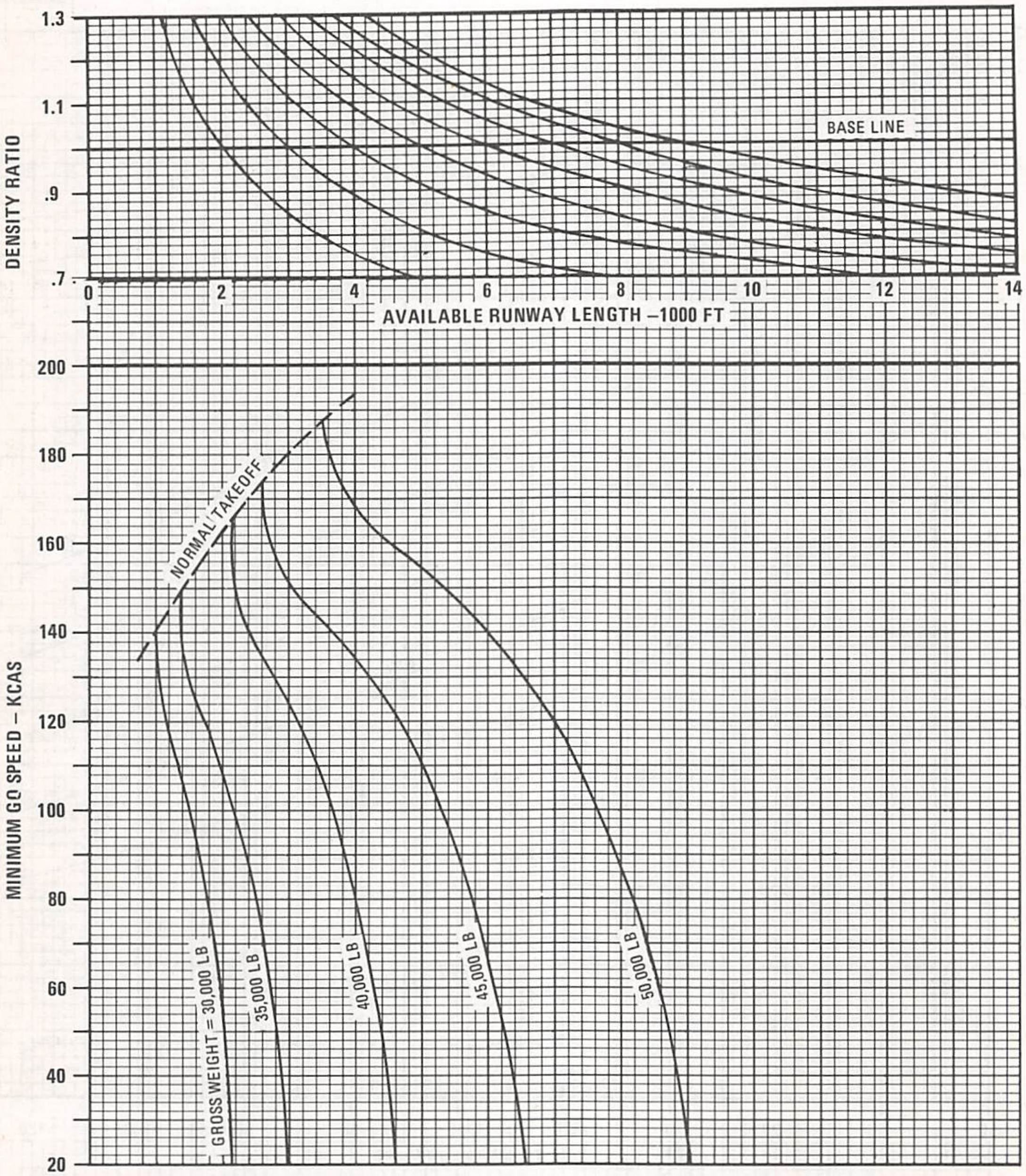
REMARKS
ENGINE (S): (2) F404-GE-400

GUIDE

DATE: 1 MARCH 1983
DATA BASIS: **FLIGHT TEST**

FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL





18AC-NFM-00-(102)A

Figure 11-10. Minimum Go Speed - Maximum Thrust

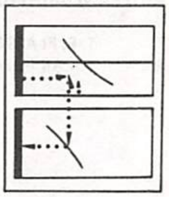
MINIMUM GO SPEED

MILITARY THRUST
HARD DRY RUNWAY

AIRPLANE CONFIGURATION
T. E. FLAPS 30°
GEAR DOWN

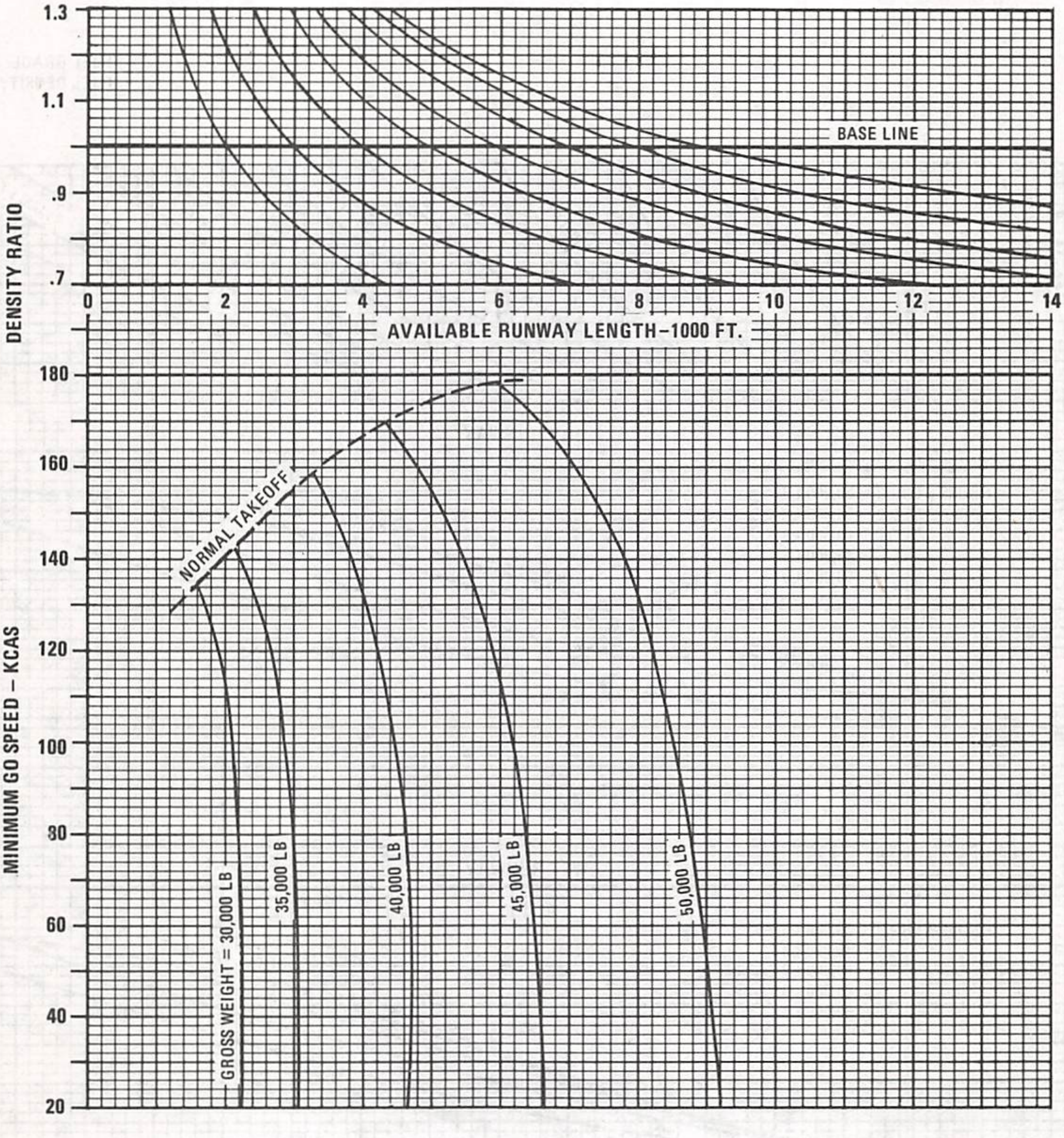
REMARKS
ENGINE (S): (2) F404--GE-400

GUIDE



DATE: 1 MARCH 1983
DATA BASIS: **FLIGHT TEST**

FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL



18AC–NFM–00–(101)A

Figure 11-11. Minimum Go Speed – Military Thrust

MAXIMUM ABORT SPEED

MAXIMUM THRUST

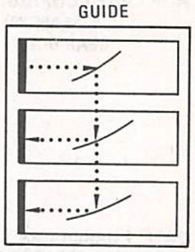
AIRPLANE CONFIGURATION

T. E. FLAPS 30°
GEAR DOWN

REMARKS

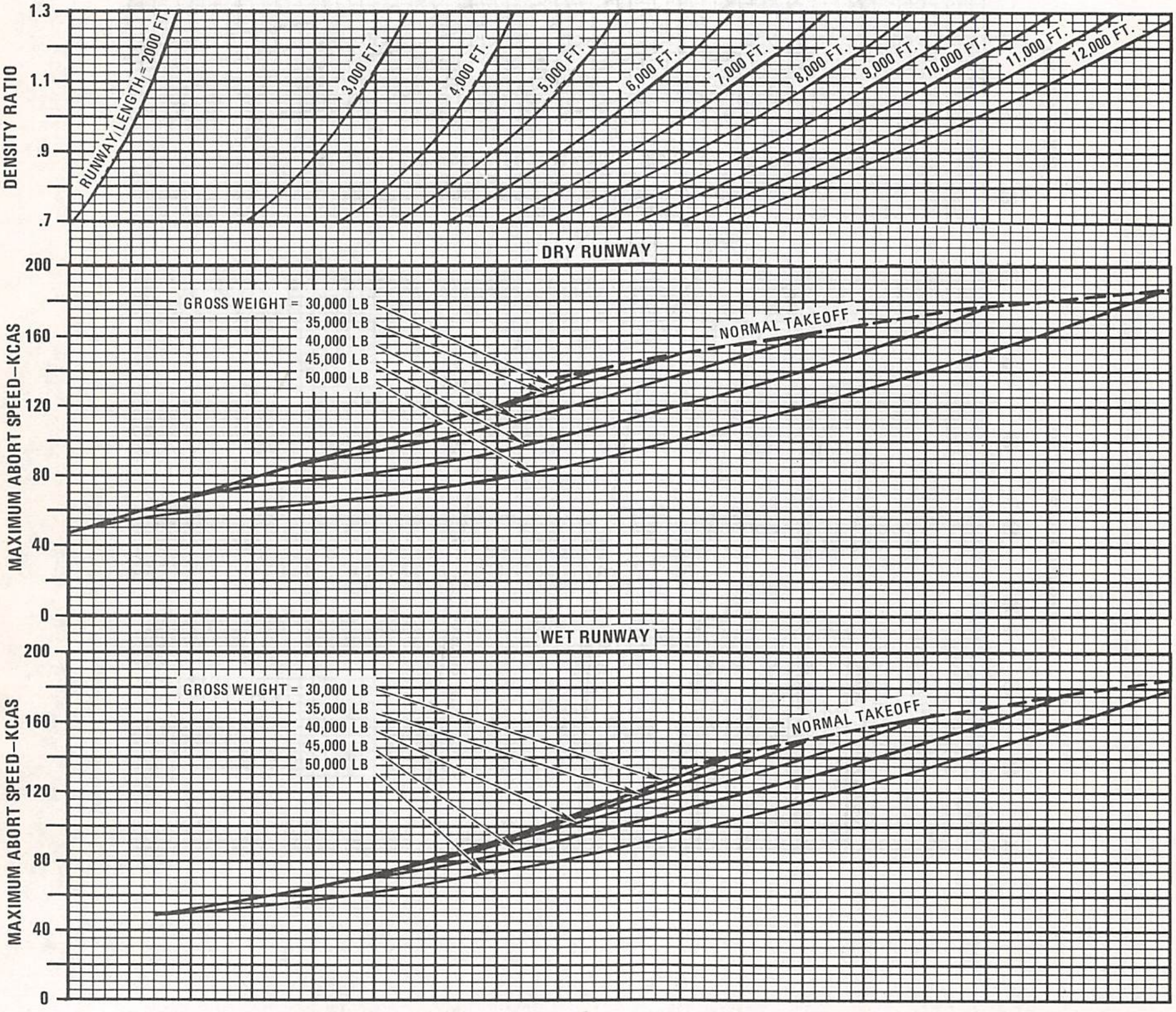
ENGINE(S): (2) F404–GE–400

GUIDE



DATE: 1 MARCH 1983
DATA BASIS: **FLIGHT TEST**

FUEL GRADE: JP–5
FUEL DENSITY: 6.8 LB/GAL



18AC–NFM–00–(99)A

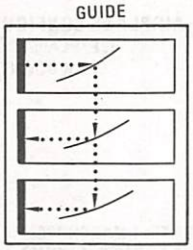
Figure 11–12. Maximum Abort Speed – Maximum Thrust

MAXIMUM ABORT SPEED

MILITARY THRUST

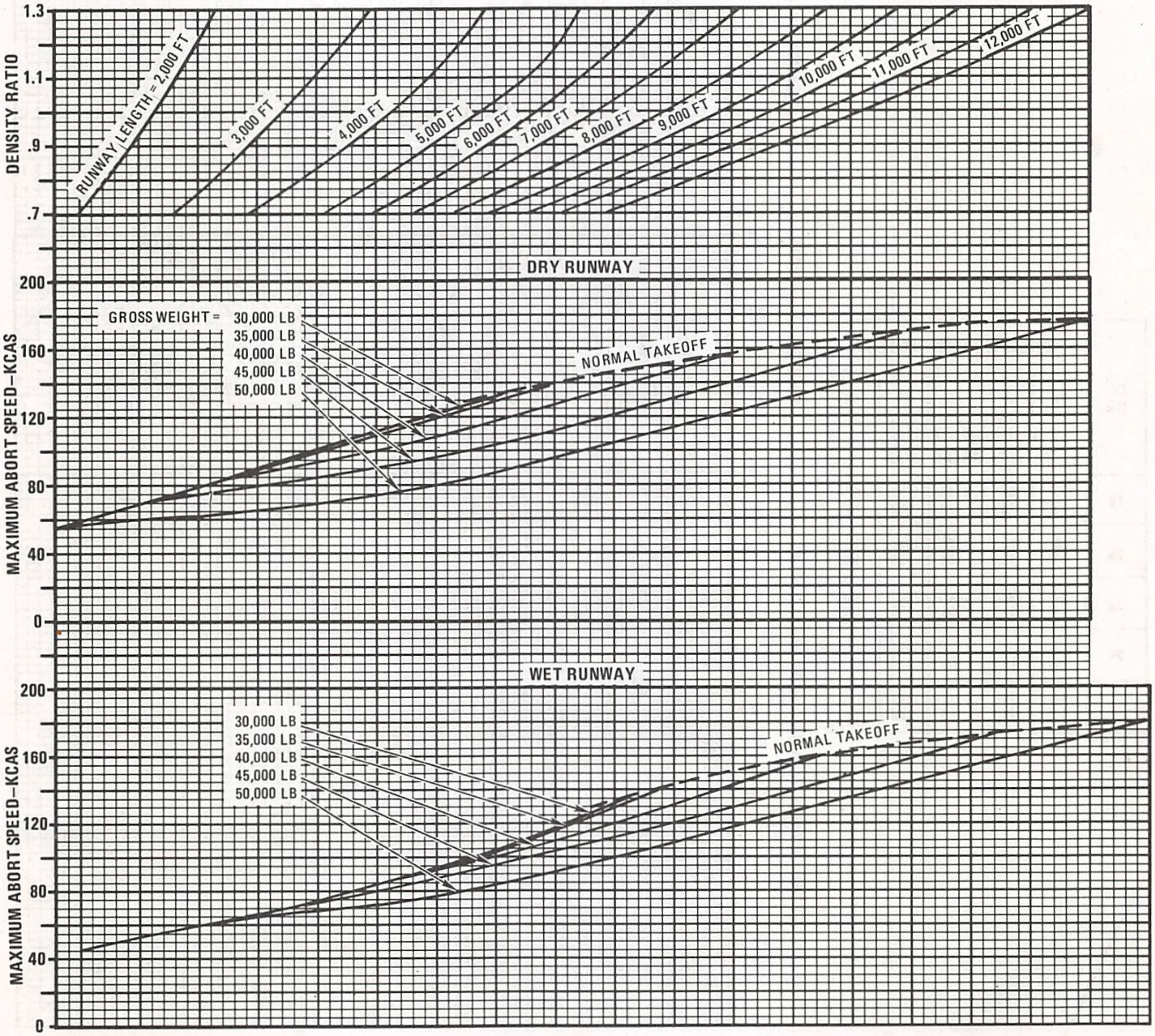
AIRPLANE CONFIGURATION
T. E. FLAPS 30°
GEAR DOWN

REMARKS
ENGINE (S): (2) F404-GE-400



DATE: 1 MARCH 1983
DATA BASIS: **FLIGHT TEST**

FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL



18AC-NFM-00-(100)A

Figure 11-13. Maximum Abort Speed - Military Thrust

TAKEOFF DISTANCE

MAXIMUM THRUST
HARD DRY RUNWAY

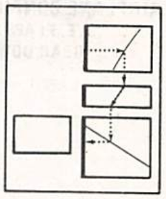
AIRPLANE CONFIGURATION
T. E. FLAPS 30°
GEAR DOWN

REMARKS
ENGINE (S): (2) F404–GE–400

NOTES

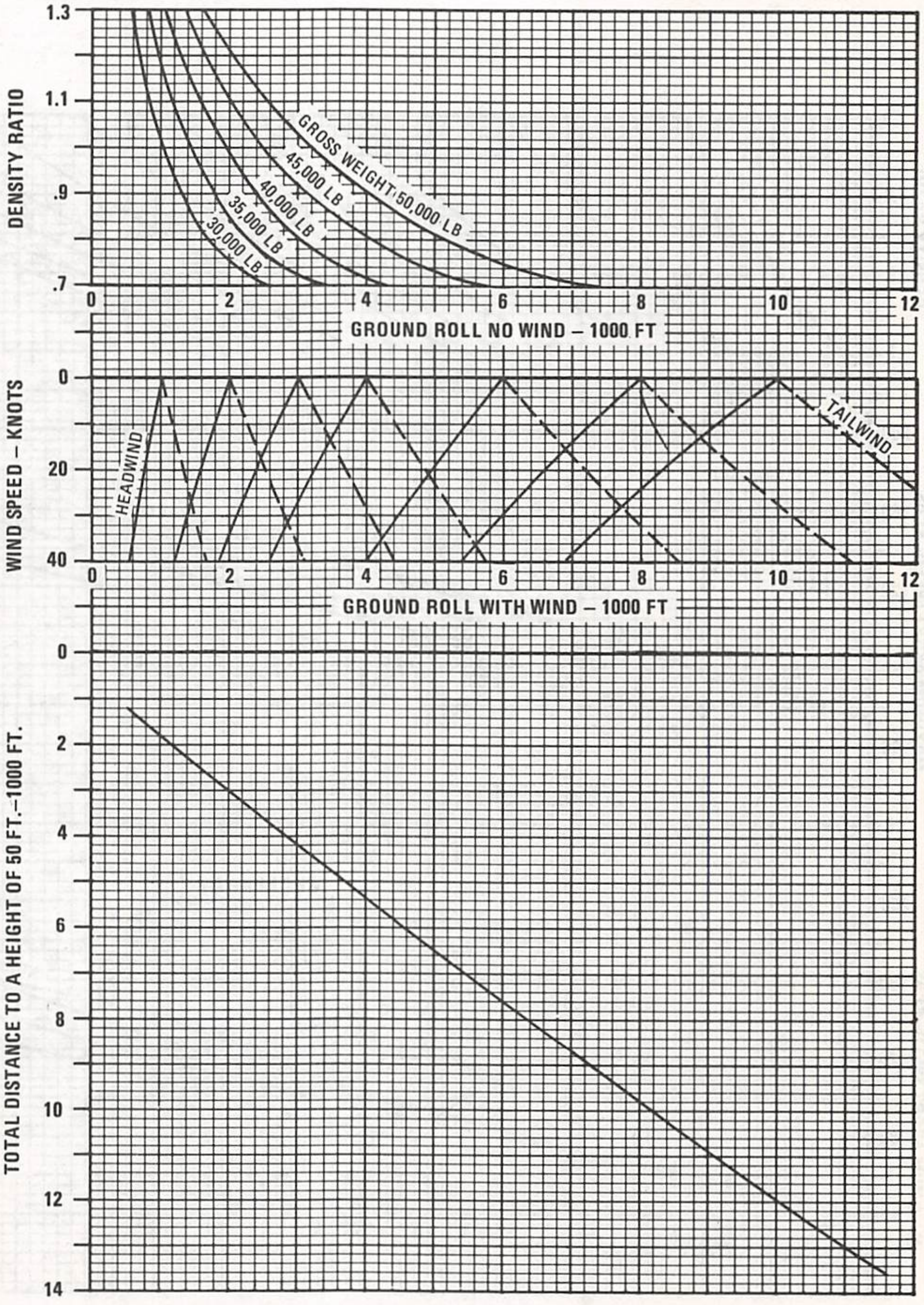
- FOR TAKEOFF WEIGHTS GREATER THAN 45,000 POUNDS, –10° INITIAL STABILATOR TRIM IS RECOMMENDED.
- GROUND ROLL DISTANCES ARE FOR A TAKEOFF CG OF 22% MAC.
- NOSEWHEEL LIFTOFF SPEEDS AND TAKEOFF SPEEDS ARE FOR SEA LEVEL AT STANDARD DAY CONDITIONS.

GUIDE



DATE: 1 MARCH 1983
DATA BASIS: **FLIGHT TEST**

FUEL GRADE: JP–5
FUEL DENSITY: 6.8 LB/GAL



CG % $\bar{c}$	GROSS WEIGHT–1000 LB				
	30	35	40	45	50
	NOSEWHEEL LIFTOFF/ TAKEOFF SPEEDS –KIAS				
18	135/ 150	146/ 159	159/ 170	172/ 182	182/ 191
20	129/ 146	140/ 154	152/ 164	164/ 175	175/ 184
22	124/ 142	133/ 149	144/ 158	156/ 169	168/ 178
24	118/ 137	127/ 145	137/ 153	149/ 163	161/ 171
26	112/ 133	131/ 140	131/ 148	142/ 158	154/ 165

18AC–NFM–00–(28)B

Figure 11–14. Takeoff Distance – Maximum Thrust

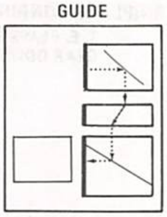
TAKEOFF DISTANCE
MILITARY THRUST
HARD DRY RUNWAY

AIRPLANE CONFIGURATION
T. E. FLAPS 30°
GEAR DOWN

REMARKS
ENGINE (S): (2) F404–GE–400

NOTES

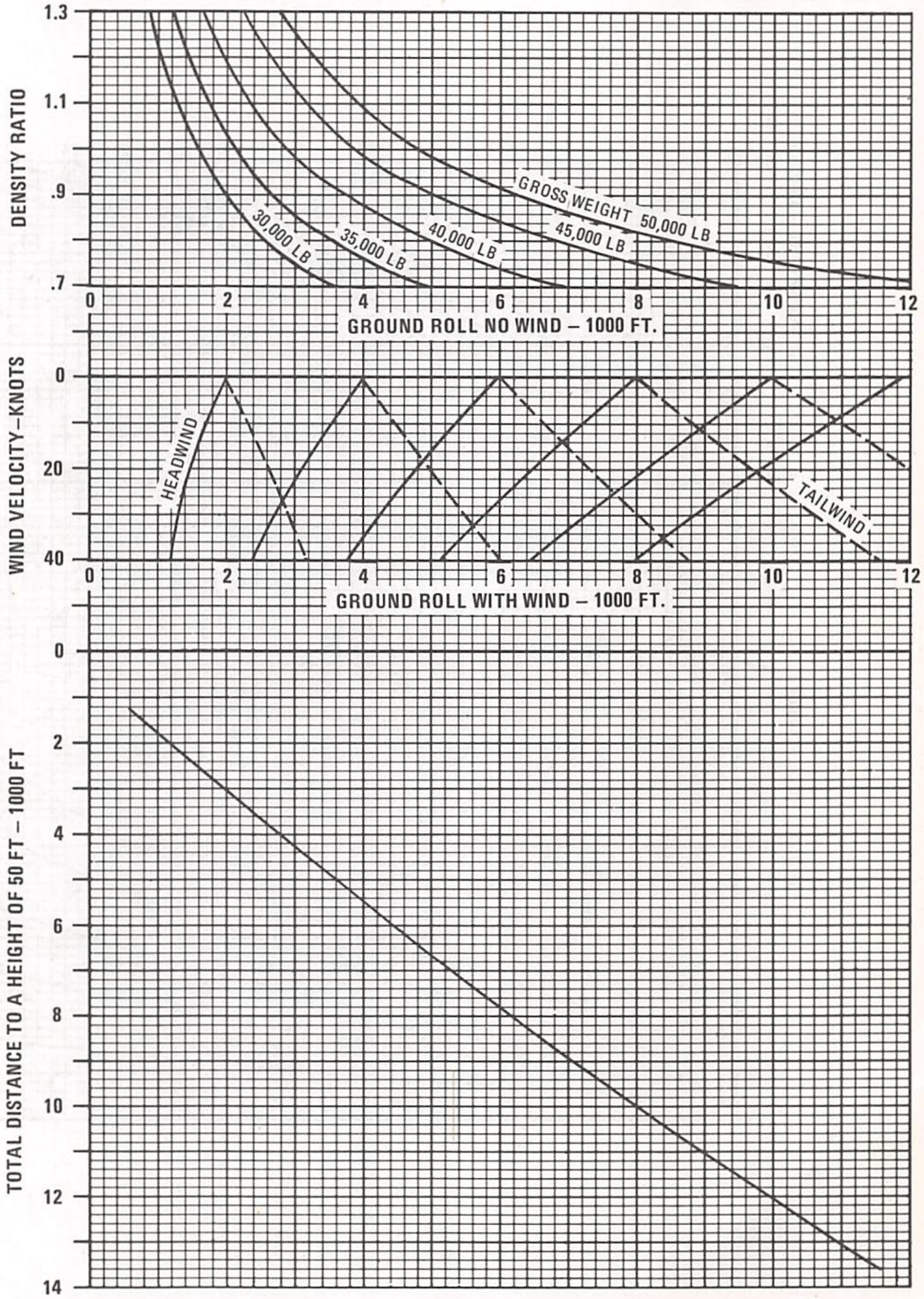
- FOR TAKEOFF WEIGHTS GREATER THAN 45,000 POUNDS, –10° INITIAL STABILATOR TRIM IS RECOMMENDED.
- GROUND ROLL DISTANCES ARE FOR A TAKEOFF CG OF 22% MAC.
- NOSEWHEEL LIFTOFF SPEEDS AND TAKEOFF SPEEDS ARE FOR SEA LEVEL AT STANDARD DAY CONDITIONS.



DATE: 1 MARCH 1983
DATA BASIS: **FLIGHT TEST**

FUEL GRADE: JP–5
FUEL DENSITY: 6.8 LB/GAL

CG %c̄	GROSS WEIGHT–1000 LB				
	30	35	40	45	50
	NOSEWHEEL LIFTOFF/ TAKEOFF SPEEDS –KIAS				
18	132/ 143	142/ 152	153/ 163	166/ 177	174/ 182
20	126/ 139	136/ 147	147/ 157	159/ 169	167/ 175
22	120/ 135	130/ 142	141 152	152/ 162	161/ 168
24	114/ 131	124/ 138	134/ 146	144/ 155	154/ 161
26	108/ 127	117/ 133	127/ 141	137/ 149	147/ 155



18AC–NFM–00–(27)B

Figure 11-15. Takeoff Distance – Military Thrust

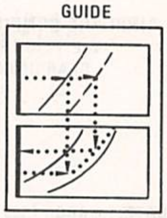
TAKEOFF GROUND ROLL CORRECTION FOR CG
MAXIMUM THRUST

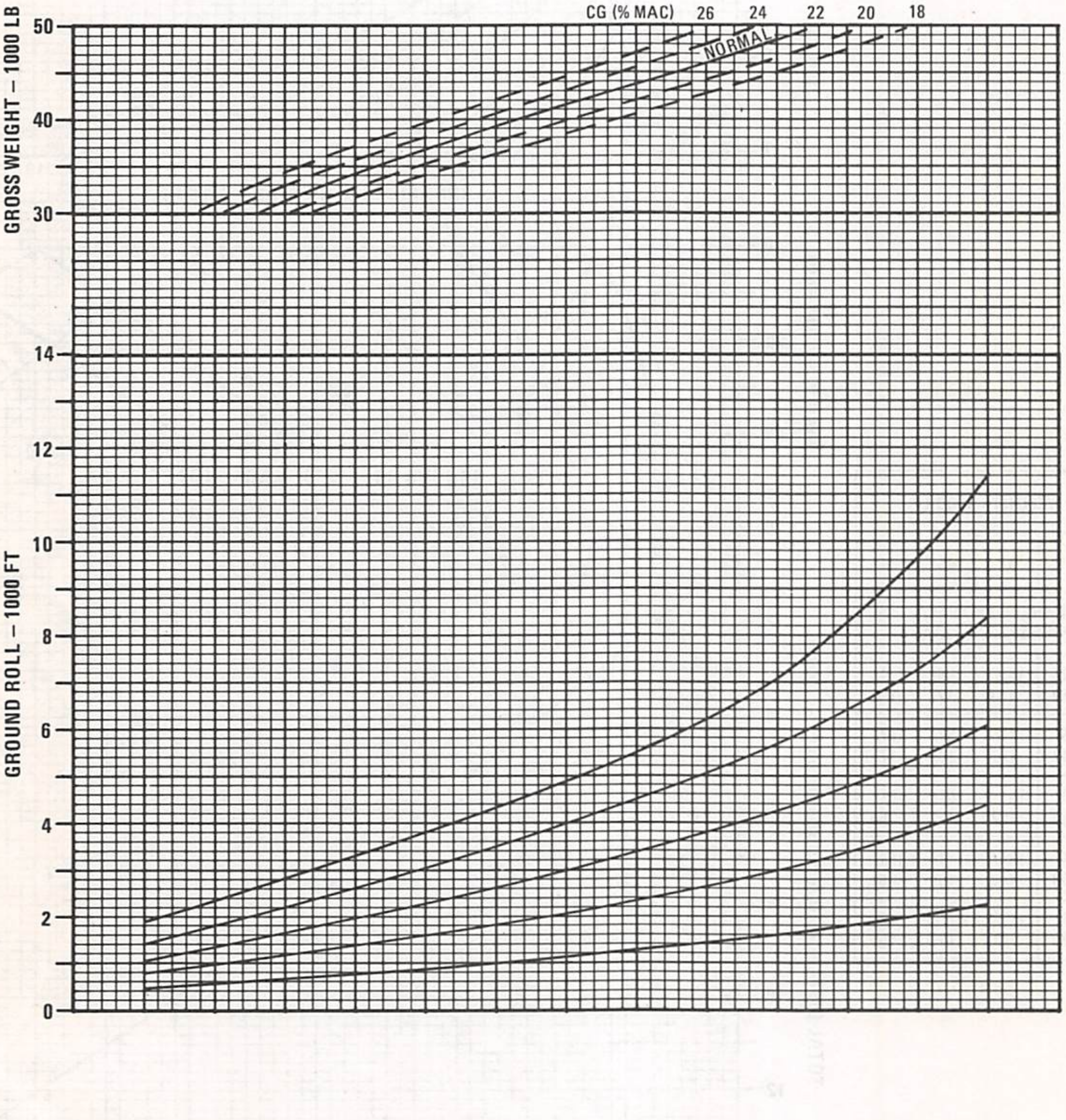
AIRPLANE CONFIGURATION
T. E. FLAPS 30°
GEAR DOWN

REMARKS
ENGINE(S): (2) F404–GE–400

DATE: 1 MARCH 1983
DATA BASIS: **FLIGHT TEST**

FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL





18AC–NFM–00–(105)A

Figure 11-16. Takeoff Ground Roll Correction for CG– Maximum Thrust

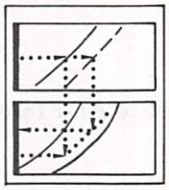
TAKEOFF GROUND ROLL CORRECTION FOR CG

MILITARY THRUST

AIRPLANE CONFIGURATION
T. E. FLAPS 30°
GEAR DOWN

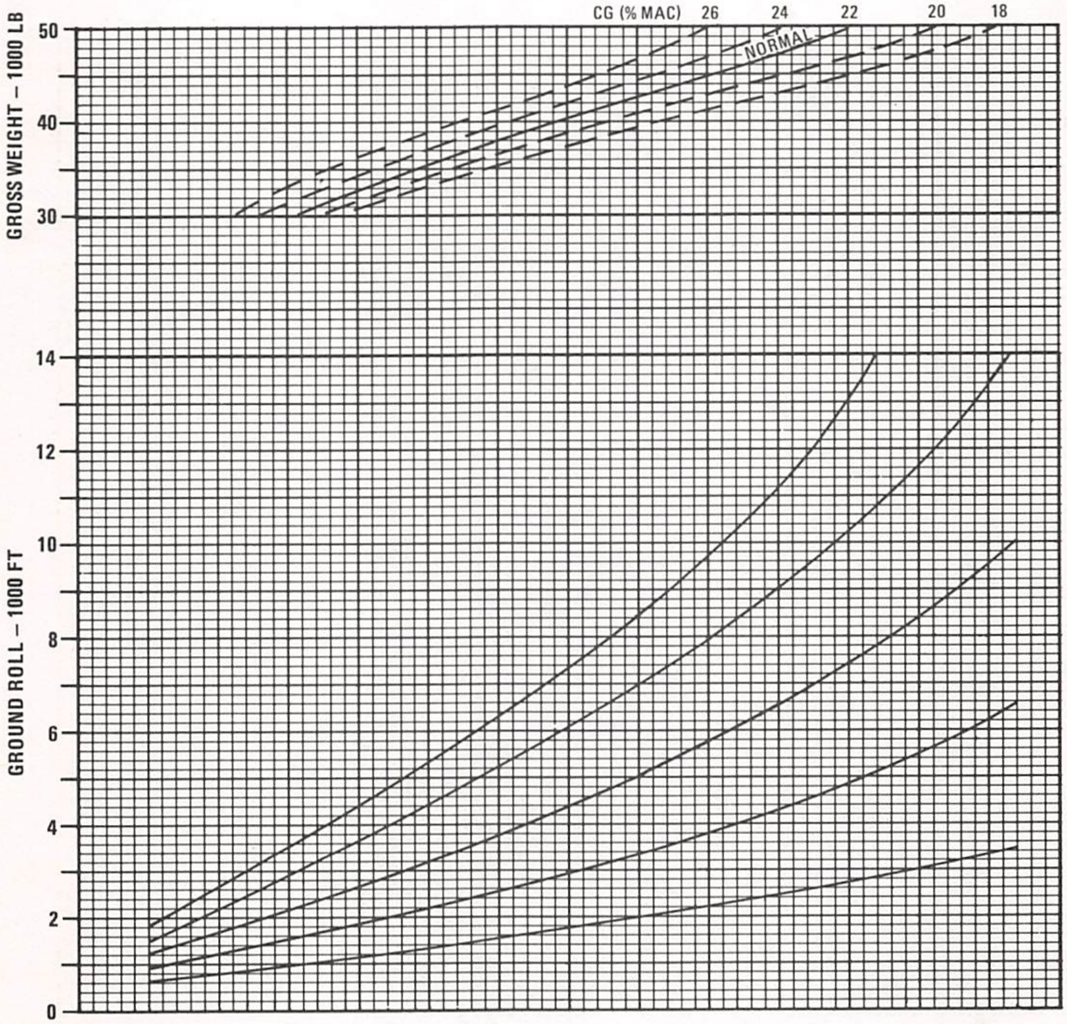
REMARKS
ENGINE(S): (2) F404–GE–400

GUIDE



DATE: 1 MARCH 1983
DATA BASIS: **FLIGHT TEST**

FUEL GRADE: JP–5
FUEL DENSITY: 6.8 LB/GAL



18AC–NFM–00–(106)A

Figure 11-17. Takeoff Ground Roll Correction for CG – Military Thrust

PART 3 - CLIMB

Refer to A1–F18AC–NFM–100.

PART 4 – RANGE

TABLE OF CONTENTS

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Refer TO A1–F18AC–TAC–100 for range charts other than BINGO.

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BINGO CHARTS

These charts (figures 11–18 thru 11–26) show time, fuel and airspeed required to travel a given distance using a combination of climb speed schedule, optimum range cruise, and optimum range descent. Fuel required values include a 1500 pound fuel reserve. Data are provided for both two–engine and single engine operation at optimum cruise altitude and at sea level.

BINGO

GEAR UP-FLAPS AUTO
WEIGHT - 26,000 POUNDS

REMARKS

ENGINE(S): (2)F404-GE-400
U.S. STANDARD DAY, 1962

DATE: 7 MAY 1981
DATA BASIS: **ESTIMATED BASED ON FLIGHT TEST**

FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

		CLIMB	CRUISE		DESCEND			SEA LEVEL CRUISE		
	INBD DIST NM	MACH OR KCAS	ALT FEET	SPEED CAS KNOTS	DIST NM	FUEL REQD LB	TIME REQD MIN	FUEL REQD LB	SPEED CAS KNOTS	TIME REQD MIN
DRAG INDEX = 0	200	425 to 0.88	40,000	255	84	3,080	29	4,370	305	39
	180		40,000	255	84	2,960	27	4,080	304	36
	160		40,000	255	84	2,840	24	3,790	303	32
	140		40,000	255	84	2,720	22	3,510	302	28
	120		35,000	275	70	2,610	19	3,220	301	24
	100		35,000	275	70	2,480	17	2,930	300	20
	80		30,000	277	58	2,340	14	2,640	299	16
	60		20,000	278	38	2,190	11	2,360	298	12
	40		10,000	286	20	2,000	8	2,070	297	8
	20		5,000	295	10	1,770	4	1,790	296	4
DRAG INDEX = 50	200	385 to 0.85	40,000	244	70	3,290	29	4,720	287	42
	180		40,000	244	70	3,150	27	4,390	286	38
	160		40,000	244	70	3,010	24	4,070	285	34
	140		40,000	244	70	2,870	22	3,740	285	30
	120		35,000	258	59	2,740	19	3,420	284	25
	100		35,000	258	59	2,590	17	3,100	283	21
	80		30,000	265	49	2,440	14	2,780	283	17
	60		20,000	266	32	2,270	11	2,460	282	13
	40		10,000	272	16	2,050	8	2,140	281	9
	20		5,000	277	8	1,800	4	1,820	281	4
DRAG INDEX = 100	200	355 to 0.82	40,000	244	61	3,470	29	4,980	279	43
	180		40,000	244	61	3,310	27	4,630	278	39
	160		40,000	244	61	3,160	24	4,280	278	35
	140		40,000	244	61	3,000	22	3,930	277	30
	120		35,000	251	52	2,860	19	3,580	277	26
	100		35,000	251	52	2,690	16	3,230	277	22
	80		30,000	258	43	2,520	14	2,880	276	17
	60		20,000	264	28	2,330	11	2,530	276	13
	40		10,000	268	14	2,100	8	2,190	275	9
	20		5,000	271	7	1,820	4	1,840	275	4
DRAG INDEX = 150	200	325 to 0.80	40,000	237	55	3,640	29	5,220	277	43
	180		40,000	237	55	3,470	27	4,840	276	39
	160		40,000	237	55	3,300	24	4,460	276	35
	140		40,000	237	55	3,120	22	4,090	275	31
	120		35,000	244	46	2,970	19	3,710	275	26
	100		35,000	244	46	2,780	16	3,340	274	22
	80		30,000	251	39	2,600	14	2,970	274	18
	60		20,000	260	25	2,380	11	2,600	273	13
	40		10,000	267	13	2,140	8	2,230	273	9
	20		5,000	269	7	1,840	4	1,870	273	4

DATA BASED ON:

1. INITIAL ALTITUDE IS SEA LEVEL
2. MILITARY THRUST CLIMB TO INDICATED ALTITUDE
3. 250 KCAS IDLE THRUST DESCENT TO SEA LEVEL (SPEEDBRAKE RETRACTED)
4. FUEL REQUIRED INCLUDES 1500 POUNDS RESERVE FUEL
5. WEIGHT = ZERO FUEL WEIGHT

18AC-NFM-00-(141)

Figure 11-18. Bingo

BINGO

GEAR UP-FLAPS AUTO
WEIGHT - 30,000 POUNDS

REMARKS

ENGINE(S): (2)F404-GE-400
U.S. STANDARD DAY, 1962

DATE: 7 MAY 1981
DATA BASIS: ESTIMATED BASED ON FLIGHT TEST

FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

		CLIMB	CRUISE		DESCEND			SEA LEVEL CRUISE		
	INBD DIST	MACH OR KCAS	ALT	SPEED CAS	DIST	FUEL REQD	TIME REQD	FUEL REQD	SPEED CAS	TIME REQD
	NM		FEET	KNOTS	NM	LB	MIN	LB	KNOTS	MIN
DRAG INDEX = 0	200	425 to 0.88	40,000	258	86	3,210	29	4,460	321	37
	180		40,000	258	86	3,080	27	4,160	321	34
	160		40,000	258	86	2,950	24	3,860	320	30
	140		40,000	258	86	2,820	22	3,570	320	26
	120		35,000	284	72	2,680	19	3,270	320	23
	100		35,000	284	72	2,550	17	2,970	319	19
	80		30,000	296	60	2,400	14	2,680	319	15
	60		20,000	292	39	2,230	11	2,380	319	11
	40		10,000	299	20	2,020	8	2,090	318	8
	20		5,000	308	10	1,780	4	1,790	318	4
DRAG INDEX = 50	200	385 to 0.85	40,000	250	73	3,440	29	4,840	302	40
	180		40,000	250	73	3,290	27	4,500	302	36
	160		40,000	250	73	3,130	24	4,160	301	32
	140		40,000	250	73	2,980	22	3,830	300	28
	120		35,000	267	61	2,830	19	3,490	300	24
	100		35,000	267	61	2,670	17	3,160	299	20
	80		30,000	279	51	2,510	14	2,820	299	16
	60		20,000	282	33	2,320	11	2,490	298	12
	40		10,000	288	17	2,080	8	2,160	297	8
	20		5,000	291	9	1,810	4	1,830	297	4
DRAG INDEX = 100	200	355 to 0.82	40,000	247	64	3,640	29	5,140	296	41
	180		40,000	247	64	3,470	27	4,770	295	37
	160		40,000	247	64	3,300	24	4,400	294	33
	140		40,000	247	64	3,130	22	4,030	293	29
	120		35,000	260	54	2,960	19	3,660	292	25
	100		35,000	260	54	2,780	16	3,300	291	21
	80		30,000	270	45	2,600	14	2,940	290	17
	60		20,000	277	29	2,380	11	2,580	289	12
	40		10,000	284	15	2,130	8	2,220	288	8
	20		5,000	287	8	1,840	4	1.860	288	4
DRAG INDEX = 150	200	325 to 0.80	40,000	244	57	3,840	29	5,400	295	41
	180		40,000	244	57	3,650	27	5,000	294	37
	160		40,000	244	57	3,460	24	4,600	293	33
	140		40,000	244	57	3,270	22	4,210	292	29
	120		35,000	256	48	3,090	19	3,820	291	25
	100		35,000	256	48	2,890	16	3,430	290	21
	80		30,000	264	40	2,690	14	3,040	289	17
	60		20,000	274	26	2,440	11	2,650	288	12
	40		10,000	282	13	2,180	8	2,270	287	8
	20		5,000	286	7	1,860	4	1,880	286	4

DATA BASED ON:

1. INITIAL ALTITUDE IS SEA LEVEL
2. MILITARY THRUST CLIMB TO INDICATED ALTITUDE
3. 250 KCAS IDLE THRUST DESCENT TO SEA LEVEL (SPEEDBRAKE RETRACTED)
4. FUEL REQUIRED INCLUDES 1500 POUNDS RESERVE FUEL
5. WEIGHT = ZERO FUEL WEIGHT

18AC-NFM-00-(142)

Figure 11-19. Bingo

BINGO

GEAR UP-HALF FLAPS
WEIGHT - 26,000 POUNDS

REMARKS

ENGINE(S): (2)F404-GE-400
U.S. STANDARD DAY, 1962

DATE: 7 MAY 1981
DATA BASIS: **ESTIMATED BASED ON FLIGHT TEST**

FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

		CLIMB	CRUISE		DESCEND			SEA LEVEL CRUISE		
	INBD DIST NM	MACH OR KCAS	ALT FEET	SPEED CAS KNOTS	DIST NM	FUEL REQD LB	TIME REQD MIN	FUEL REQD LB	SPEED CAS KNOTS	TIME REQD MIN
DRAG INDEX = 0	200	190 to 0.60	35,000	194	32	5,290	40	7,580	205	59
	180		35,000	194	32	4,960	36	6,950	204	53
	160		35,000	194	32	4,620	32	6,320	203	47
	140		35,000	194	32	4,290	29	5,700	202	42
	120		35,000	194	32	3,960	25	5,090	202	36
	100		30,000	196	27	3,630	22	4,480	201	30
	80		30,000	196	27	3,290	18	3,870	201	24
	60		25,000	195	22	2,930	14	3,270	200	18
	40		15,000	197	13	2,540	11	2,680	200	12
	20		5,000	197	4	2,070	6	2,090	199	6
DRAG INDEX = 50	200	190 to 0.60	30,000	196	25	5,640	41	7,910	204	59
	180		30,000	196	25	5,260	37	7,240	203	53
	160		30,000	196	25	4,870	34	6,580	202	47
	140		30,000	196	25	4,490	30	5,930	202	42
	120		30,000	196	25	4,120	26	5,280	201	36
	100		30,000	196	25	3,750	22	4,630	200	30
	80		30,000	196	25	3,390	18	4,000	200	24
	60		25,000	193	20	3,000	14	3,360	199	18
	40		15,000	195	12	2,590	11	2,740	199	12
	20		5,000	196	4	2,100	6	2,120	198	6
DRAG INDEX = 100	200	190 to 0.60	30,000	195	23	5,910	41	8,250	205	58
	180		30,000	195	23	5,500	37	7,540	204	53
	160		30,000	195	23	5,080	34	6,840	203	47
	140		30,000	195	23	4,680	30	6,150	202	42
	120		30,000	195	23	4,270	26	5,470	201	36
	100		30,000	195	23	3,880	22	4,790	201	30
	80		30,000	195	23	3,490	18	4,120	200	24
	60		25,000	193	19	3,070	14	3,460	199	18
	40		15,000	195	11	2,640	11	2,800	199	12
	20		5,000	196	4	2,130	6	2,150	198	6
DRAG INDEX = 150	200	190 to 0.60	30,000	193	22	6,160	42	8,570	207	58
	180		30,000	193	22	5,720	38	7,830	205	53
	160		30,000	193	22	5,290	34	7,100	204	47
	140		30,000	193	22	4,860	30	6,370	203	42
	120		30,000	193	22	4,430	26	5,650	202	36
	100		30,000	193	22	4,010	22	4,940	202	30
	80		30,000	193	22	3,590	18	4,240	201	24
	60		25,000	193	18	3,150	14	3,540	200	18
	40		15,000	196	11	2,690	11	2,860	199	12
	20		5,000	196	4	2,150	6	2,170	199	6

DATA BASED ON:

1. INITIAL ALTITUDE IS SEA LEVEL
2. MILITARY THRUST CLIMB TO INDICATED ALTITUDE
3. 200 KCAS IDLE THRUST DESCENT TO SEA LEVEL (SPEEDBRAKE RETRACTED)
4. FUEL REQUIRED INCLUDES 1500 POUNDS RESERVE FUEL
5. WEIGHT = ZERO FUEL WEIGHT

18AC–NFM–00–(143)

Figure 11–20. Bingo

BINGO

GEAR UP-HALF FLAPS
WEIGHT - 30,000 POUNDS

REMARKS

ENGINE(S): (2)F404–GE–400
U.S. STANDARD DAY, 1962

DATE: 7 MAY 1981
DATA BASIS: **ESTIMATED BASED ON FLIGHT TEST**

FUEL GRADE: JP–5
FUEL DENSITY: 6.8 LB/GAL

		CLIMB	CRUISE		DESCEND			SEA LEVEL CRUISE		
	INBD DIST NM	MACH OR KCAS	ALT FEET	SPEED CAS KNOTS	DIST NM	FUEL REQD LB	TIME REQD MIN	FUEL REQD LB	SPEED CAS KNOTS	TIME REQD MIN
DRAG INDEX = 0	200	190 to 0.60	30,000	212	28	5,810	40	7,950	223	54
	180		30,000	212	28	5,410	36	7,290	222	49
	160		30,000	212	28	5,020	33	6,620	220	44
	140		30,000	212	28	4,630	29	5,960	219	38
	120		30,000	212	28	4,250	26	5,300	217	33
	100		30,000	212	28	3,870	22	4,650	216	28
	80		25,000	210	23	3,480	18	4,010	215	22
	60		20,000	210	18	3,070	15	3,370	213	17
	40		15,000	208	14	2,620	10	2,740	212	11
	20		5,000	211	5	2,100	6	2,120	210	6
DRAG INDEX = 50	200	190 to 0.60	30,000	209	26	6,080	40	8,310	222	54
	180		30,000	209	26	5,660	36	7,610	221	49
	160		30,000	209	26	5,240	33	6,900	220	44
	140		30,000	209	26	4,830	29	6,200	218	38
	120		30,000	209	26	4,420	26	5,510	217	33
	100		30,000	209	26	4,010	22	4,820	215	28
	80		25,000	209	22	3,580	18	4,150	214	22
	60		20,000	209	17	3,150	15	3,470	212	17
	40		15,000	207	13	2,680	10	2,810	211	11
	20		5,000	210	4	2,130	6	2,150	209	6
DRAG INDEX = 100	200	190 to 0.60	25,000	210	20	6,520	42	8,660	223	54
	180		25,000	210	20	6,040	38	7,920	222	49
	160		25,000	210	20	5,560	34	7,180	221	44
	140		25,000	210	20	5,090	30	6,440	219	38
	120		25,000	210	20	4,620	26	5,720	218	33
	100		25,000	210	20	4,160	22	4,990	216	28
	80		25,000	210	20	3,700	18	4,280	214	22
	60		20,000	209	16	3,230	15	3,570	213	17
	40		15,000	207	12	2,730	10	2,880	211	11
	20		5,000	210	4	2,170	6	2,180	210	6
DRAG INDEX = 150	200	190 to 0.60	25,000	210	19	6,820	42	9,000	224	54
	180		25,000	210	19	6,310	38	8,220	223	49
	160		25,000	210	19	5,800	34	7,450	222	44
	140		25,000	210	19	5,290	30	6,680	220	38
	120		25,000	210	19	4,790	26	5,910	219	33
	100		25,000	210	19	4,300	22	5,160	217	28
	80		25,000	210	19	3,820	18	4,410	215	22
	60		20,000	209	15	3,320	15	3,670	214	17
	40		15,000	208	11	2,790	10	2,940	212	11
	20		5,000	210	4	2,200	6	2,220	210	6

DATA BASED ON:

1. INITIAL ALTITUDE IS SEA LEVEL
2. MILITARY THRUST CLIMB TO INDICATED ALTITUDE
3. 200 KCAS IDLE THRUST DESCENT TO SEA LEVEL (SPEEDBRAKE RETRACTED)
4. FUEL REQUIRED INCLUDES 1500 POUNDS RESERVE FUEL
5. WEIGHT = ZERO FUEL WEIGHT

18AC–NFM–00–(144)

Figure 11-21. Bingo

BINGO

GEAR DOWN - FLAPS AUTO
WEIGHT - 26,000 POUNDS

REMARKS

ENGINE(S): (2)F404-GE-400
U.S. STANDARD DAY, 1962

DATE: 7 MAY 1981
DATA BASIS: **ESTIMATED BASED ON FLIGHT TEST**

FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

		CLIMB	CRUISE		DESCEND			SEA LEVEL CRUISE		
	INBD DIST	MACH OR KCAS	ALT	SPEED CAS	DIST	FUEL REQD	TIME REQD	FUEL REQD	SPEED CAS	TIME REQD
	NM		FEET	KNOTS	NM	LB	MIN	LB	KNOTS	MIN
DRAG INDEX = 0	200	230 to 0.85	35,000	211	34	4,930	36	7,130	226	53
	180		35,000	211	34	4,620	33	6,550	225	48
	160		35,000	211	34	4,330	30	5,970	224	43
	140		35,000	211	34	4,030	26	5,390	223	37
	120		30,000	210	29	3,740	24	4,820	222	32
	100		30,000	210	29	3,430	20	4,260	221	27
	80		25,000	210	24	3,130	17	3,700	220	22
	60		25,000	210	24	2,790	13	3,140	219	16
	40		15,000	210	14	2,430	10	2,590	218	11
	20		10,000	211	9	2,010	5	2,040	217	6
DRAG INDEX = 50	200	230 to 0.85	30,000	206	27	5,250	39	7,470	223	54
	180		30,000	206	27	4,900	35	6,850	222	49
	160		30,000	206	27	4,560	32	6,230	221	44
	140		30,000	206	27	4,220	28	5,620	220	38
	120		30,000	206	27	3,880	24	5,010	219	33
	100		30,000	206	27	3,550	20	4,420	218	27
	80		25,000	207	22	3,220	17	3,820	217	22
	60		25,000	207	22	2,860	13	3,230	217	16
	40		15,000	208	13	2,480	10	2,650	216	11
	20		10,000	209	9	2,040	5	2,070	215	6
DRAG INDEX = 100	200	230 to 0.85	30,000	206	25	5,510	39	7,780	224	54
	180		30,000	206	25	5,130	35	7,130	223	49
	160		30,000	206	25	4,760	32	6,470	222	44
	140		30,000	206	25	4,390	28	5,830	221	38
	120		30,000	206	25	4,030	24	5,190	220	33
	100		30,000	206	25	3,670	20	4,560	219	27
	80		25,000	207	21	3,310	17	3,940	218	22
	60		25,000	207	21	2,930	13	3,320	217	16
	40		15,000	208	12	2,530	10	2,710	216	11
	20		10,000	210	8	2,060	5	2,100	215	6
DRAG INDEX = 150	200	230 to 0.85	30,000	206	24	5,750	38	8,070	227	54
	180		30,000	206	24	5,350	34	7,390	226	48
	160		30,000	206	24	4,960	31	6,710	225	44
	140		30,000	206	24	4,570	28	6,030	223	38
	120		30,000	206	24	4,180	24	5,360	222	33
	100		30,000	206	24	3,800	20	4,700	221	27
	80		25,000	207	19	3,400	17	4,050	220	22
	60		25,000	207	19	3,000	13	3,400	219	16
	40		15,000	208	12	2,580	10	2,760	218	11
	20		10,000	211	8	2,090	5	2,130	216	6

DATA BASED ON:

1. INITIAL ALTITUDE IS SEA LEVEL
2. MILITARY THRUST CLIMB TO INDICATED ALTITUDE
3. 200 KCAS IDLE THRUST DESCENT TO SEA LEVEL (SPEEDBRAKE RETRACTED)
4. FUEL REQUIRED INCLUDES 1500 POUNDS RESERVE FUEL
5. WEIGHT = ZERO FUEL WEIGHT

18AC-NFM-00-(145)

Figure 11-22. Bingo

BINGO

ONE ENGINE OPERATING
GEAR UP - FLAPS AUTO
WEIGHT - 26,000 POUNDS

REMARKS

DATE: 7 MAY 1981
DATA BASIS: **ESTIMATED BASED ON FLIGHT TEST**

ENGINE(S): (2)F404–GE–400
U.S. STANDARD DAY, 1962
INOPERATIVE ENGINE WINDMILLING

FUEL GRADE: JP–5
FUEL DENSITY: 6.8 LB/GAL

		CLIMB	CRUISE		DESCEND			SEA LEVEL CRUISE		
	INBD DIST NM	MACH OR KCAS	ALT FEET	SPEED CAS KNOTS	DIST NM	FUEL REQD LB	TIME REQD MIN	FUEL REQD LB	SPEED CAS KNOTS	TIME REQD MIN
DRAG INDEX = 0	200	290 to 0.85	30,000	266	49	3,340	32	4,120	272	44
	180		30,000	266	49	3,190	29	3,850	271	40
	160		30,000	266	49	3,040	26	3,590	271	35
	140		25,000	262	40	2,880	24	3,320	270	31
	120		20,000	261	32	2,730	22	3,060	270	27
	100		20,000	261	32	2,550	18	2,800	269	22
	80		15,000	261	24	2,370	16	2,540	269	18
	60		10,000	264	16	2,190	12	2,280	268	14
	40		10,000	264	16	1,970	8	2,020	268	9
	20		5,000	263	8	1,750	4	1,760	267	5
DRAG INDEX = 50	200	290 to 0.85	25,000	253	35	3,680	34	4,470	264	45
	180		25,000	253	35	3,480	31	4,170	264	41
	160		25,000	253	35	3,290	28	3,870	263	36
	140		25,000	253	35	3,100	24	3,570	262	32
	120		20,000	254	27	2,910	22	3,270	261	28
	100		20,000	254	27	2,700	18	2,970	261	23
	80		15,000	254	21	2,490	16	2,680	260	18
	60		10,000	256	14	2,280	12	2,380	259	14
	40		10,000	256	14	2,040	8	2,090	259	9
	20		5,000	255	7	1,780	4	1,790	258	5
DRAG INDEX = 100	200	290 to 0.85	25,000	249	31	3,930	34	4,770	264	45
	180		25,000	249	31	3,720	31	4,440	263	41
	160		25,000	249	31	3,500	28	4,100	262	36
	140		25,000	249	31	3,290	24	3,770	261	32
	120		20,000	252	25	3,070	22	3,440	260	28
	100		20,000	252	25	2,840	18	3,120	260	23
	80		15,000	253	18	2,600	16	2,790	259	18
	60		10,000	254	12	2,360	12	2,470	258	14
	40		10,000	254	12	2,090	8	2,140	257	9
	20		5,000	254	6	1,810	4	1,820	257	5
DRAG INDEX = 150	200	290 to 0.85	20,000	250	22	4,260	36	5,020	265	45
	180		20,000	250	22	4,000	32	4,660	264	41
	160		20,000	250	22	3,750	29	4,300	263	36
	140		20,000	250	22	3,490	25	3,950	262	32
	120		20,000	250	22	3,240	22	3,590	261	28
	100		20,000	250	22	2,980	18	3,240	261	23
	80		15,000	253	17	2,700	16	2,890	260	18
	60		10,000	255	11	2,430	12	2,540	259	14
	40		10,000	255	11	2,140	8	2,190	258	9
	20		5,000	255	6	1,840	4	1,840	258	5

DATA BASED ON:

1. INITIAL ALTITUDE IS SEA LEVEL
2. MILITARY THRUST CLIMB TO INDICATED ALTITUDE
3. 250 KCAS IDLE THRUST DESCENT TO SEA LEVEL (SPEEDBRAKE RETRACTED)
4. FUEL REQUIRED INCLUDES 1500 POUNDS RESERVE FUEL
5. WEIGHT = ZERO FUEL WEIGHT

18AC–NFM–00–(146)

Figure 11-23. Bingo

BINGO

ONE ENGINE OPERATING
GEAR UP - FLAPS AUTO
WEIGHT - 30,000 POUNDS

REMARKS

DATE: 7 MAY 1981
DATA BASIS: **ESTIMATED BASED ON FLIGHT TEST**

ENGINE(S): (2)F404–GE–400
U.S. STANDARD DAY, 1962
INOPERATIVE ENGINE WINDMILLING

FUEL GRADE: JP–5
FUEL DENSITY: 6.8 LB/GAL

		CLIMB	CRUISE		DESCEND			SEA LEVEL CRUISE		
	INBD DIST NM	MACH OR KCAS	ALT FEET	SPEED CAS KNOTS	DIST NM	FUEL REQD LB	TIME REQD MIN	FUEL REQD LB	SPEED CAS KNOTS	TIME REQD MIN
DRAG INDEX = 0	200	290 to 0.85	30,000	287	51	3,250	32	4,260	291	41
	180		30,000	287	51	3,360	29	3,980	291	37
	160		30,000	287	51	3,190	27	3,700	290	33
	140		25,000	282	42	3,000	24	3,420	289	29
	120		20,000	279	33	2,830	22	3,140	288	25
	100		20,000	279	33	2,640	18	2,870	287	21
	80		15,000	279	25	2,440	15	2,590	287	17
	60		10,000	280	17	2,230	12	2,320	286	13
	40		10,000	280	17	2,010	8	2,040	285	8
	20		5,000	283	8	1,770	4	1,770	284	4
DRAG INDEX = 50	200	290 to 0.85	25,000	270	37	3,880	33	4,650	283	42
	180		25,000	270	37	3,670	30	4,330	282	38
	160		25,000	270	37	3,460	27	4,010	281	34
	140		25,000	270	37	3,250	24	3,690	280	30
	120		20,000	271	29	3,020	22	3,370	280	26
	100		20,000	271	29	2,800	18	3,060	279	22
	80		15,000	271	22	2,570	15	2,740	278	17
	60		10,000	272	14	2,330	12	2,430	278	13
	40		10,000	272	14	2,080	8	2,120	277	9
	20		5,000	274	7	1,800	4	1,810	276	4
DRAG INDEX = 100	200	290 to 0.85	20,000	268	26	4,210	35	4,970	281	42
	180		20,000	268	26	3,960	32	4,610	280	38
	160		20,000	268	26	3,700	28	4,260	280	34
	140		20,000	268	26	3,450	25	3,910	279	30
	120		20,000	268	26	3,200	22	3,560	278	26
	100		20,000	268	26	2,960	18	3,210	277	22
	80		15,000	269	19	2,690	15	2,870	277	17
	60		10,000	271	13	2,420	12	2,520	276	13
	40		10,000	271	13	2,140	8	2,180	275	9
	20		5,000	273	6	1,830	4	1,840	275	4
DRAG INDEX = 150	200	290 to 0.85	20,000	263	24	4,470	35	5,250	282	42
	180		20,000	263	24	4,190	32	4,860	282	38
	160		20,000	263	24	3,910	28	4,480	281	34
	140		20,000	263	24	3,630	25	4,100	280	30
	120		20,000	263	24	3,360	22	3,720	279	26
	100		20,000	263	24	3,090	18	3,350	278	22
	80		15,000	267	18	2,700	15	2,970	278	17
	60		10,000	272	12	2,500	12	2,600	277	13
	40		10,000	272	12	2,190	8	2,230	276	9
	20		5,000	274	6	1,860	4	1,870	275	4

DATA BASED ON:

1. INITIAL ALTITUDE IS SEA LEVEL
2. MILITARY THRUST CLIMB TO INDICATED ALTITUDE
3. 250 KCAS IDLE THRUST DESCENT TO SEA LEVEL (SPEEDBRAKE RETRACTED)
4. FUEL REQUIRED INCLUDES 1500 POUNDS RESERVE FUEL
5. WEIGHT = ZERO FUEL WEIGHT

18AC–NFM–00–(147)

Figure 11-24. Bingo

BINGO

ONE ENGINE OPERATING
GEAR UP - HALF FLAPS
WEIGHT - 26,000 POUNDS

REMARKS

ENGINE(S): (2)F404–GE–400
U.S. STANDARD DAY, 1962
INOPERATIVE ENGINE WINDMILLING

DATE: 7 MAY 1981
DATA BASIS: **ESTIMATED BASED ON FLIGHT TEST**

FUEL GRADE: JP–5
FUEL DENSITY: 6.8 LB/GAL

		CLIMB	CRUISE		DESCEND			SEA LEVEL CRUISE		
	INBD DIST	MACH OR KCAS	ALT	SPEED CAS	DIST	FUEL REQD	TIME REQD	FUEL REQD	SPEED CAS	TIME REQD
	NM		FEET	KNOTS	NM	LB	MIN	LB	KNOTS	MIN
DRAG INDEX = 0	200	150 to 0.40	10,000	190	8	6,830	57	7,350	197	61
	180		10,000	190	8	6,280	52	6,740	197	55
	160		10,000	190	8	5,740	46	6,130	196	49
	140		10,000	189	8	5,200	40	5,530	195	43
	120		10,000	189	8	4,660	35	4,940	195	37
	100		10,000	189	8	4,140	29	4,350	194	31
	80		10,000	188	8	3,640	24	3,770	194	25
	60		5,000	191	4	3,150	18	3,190	193	19
	40		S.L.	192	–	2,620	12	2,620	192	12
	20		S.L.	192	–	2,060	6	2,060	192	6
DRAG INDEX = 50	200	150 to 0.40	10,000	186	7	7,200	58	7,720	196	61
	180		10,000	186	7	6,610	53	7,060	195	55
	160		10,000	186	7	6,020	47	6,420	195	49
	140		10,000	186	7	5,440	41	5,780	194	43
	120		10,000	186	7	4,870	36	5,150	194	37
	100		10,000	185	7	4,310	30	4,520	193	31
	80		10,000	185	7	3,770	24	3,900	193	25
	60		5,000	189	4	3,250	18	3,290	192	19
	40		S.L.	192	–	2,690	13	2,690	192	13
	20		S.L.	192	–	2,090	6	2,090	192	6
DRAG INDEX = 100	200	150 to 0.40	5,000	199	4	7,850	58	8,100	197	61
	180		5,000	197	4	7,180	52	7,390	196	55
	160		5,000	196	4	6,520	47	6,700	195	49
	140		5,000	194	4	5,860	41	6,030	195	43
	120		5,000	193	4	5,220	36	5,220	194	37
	100		5,000	192	4	4,580	30	4,580	193	31
	80		5,000	190	4	3,960	24	3,960	193	25
	60		5,000	189	4	3,350	19	3,350	192	19
	40		S.L.	192	–	2,760	13	2,760	192	13
	20		S.L.	192	–	2,120	6	2,120	192	6
DRAG INDEX = 150	200	150 to 0.40	5,000	199	3	8,260	58	8,480	198	61
	180		5,000	197	3	7,540	53	7,730	197	55
	160		5,000	196	3	6,830	47	6,990	196	49
	140		5,000	194	3	6,130	42	6,270	195	43
	120		5,000	193	3	5,440	36	5,570	194	37
	100		5,000	192	3	4,760	30	4,810	194	31
	80		5,000	190	3	4,100	24	4,180	193	25
	60		5,000	189	3	3,460	19	3,490	193	19
	40		S.L.	192	–	2,820	12	2,820	192	12
	20		S.L.	192	–	2,160	6	2,160	192	6

DATA BASED ON:

1. INITIAL ALTITUDE IS SEA LEVEL
2. MILITARY THRUST CLIMB TO INDICATED ALTITUDE
3. 200 KCAS IDLE THRUST DESCENT TO SEA LEVEL (SPEEDBRAKE RETRACTED)
4. FUEL REQUIRED INCLUDES 1500 POUNDS RESERVE FUEL
5. WEIGHT = ZERO FUEL WEIGHT

18AC–NFM–00–(148)

Figure 11–25. Bingo

BINGO

ONE ENGINE OPERATING
GEAR DOWN - FLAPS AUTO
WEIGHT 26,000 POUNDS

REMARKS

DATE: 7 MAY 1981
DATA BASIS: **ESTIMATED BASED ON FLIGHT TEST**

ENGINE(S): (2)F404-GE-400
U.S. STANDARD DAY, 1962
INOPERATIVE ENGINE WINDMILLING

FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

		CLIMB	CRUISE		DESCEND			SEA LEVEL CRUISE		
	INBD DIST NM	MACH OR KCAS	ALT FEET	SPEED CAS KNOTS	DIST NM	FUEL REQD LB	TIME REQD MIN	FUEL REQD LB	SPEED CAS KNOTS	TIME REQD MIN
DRAG INDEX = 0	200	190 to 0.45	15,000	198	13	6,060	50	6,960	213	56
	180		15,000	198	13	5,610	46	6,390	212	51
	160		15,000	198	13	5,160	40	5,820	211	45
	140		15,000	198	13	4,710	36	5,260	211	40
	120		15,000	198	13	4,270	31	4,700	210	34
	100		15,000	198	13	3,830	26	4,150	209	29
	80		15,000	198	13	3,400	21	3,610	209	23
	60		10,000	203	9	2,950	16	3,070	208	17
	40		5,000	204	5	2,500	11	2,540	207	12
	20		S.L.	207	–	2,020	6	2,020	207	6
DRAG INDEX = 50	200	190 to 0.45	10,000	201	8	6,650	52	7,260	212	57
	180		10,000	201	8	6,110	47	6,650	211	52
	160		10,000	201	8	5,590	42	6,050	210	46
	140		10,000	201	8	5,060	37	5,460	209	40
	120		10,000	201	8	4,550	32	4,880	209	34
	100		10,000	201	8	4,040	27	4,300	208	29
	80		10,000	201	8	3,550	22	3,730	207	23
	60		10,000	201	8	3,050	17	3,160	206	17
	40		5,000	202	4	2,570	11	2,600	206	12
	20		S.L.	205	–	2,050	6	2,050	205	6
DRAG INDEX = 100	200	190 to 0.45	10,000	201	8	6,980	52	7,610	212	57
	180		10,000	201	8	6,410	47	6,970	211	51
	160		10,000	201	8	5,850	42	6,330	211	46
	140		10,000	201	8	5,300	37	5,700	210	40
	120		10,000	201	8	4,750	32	5,080	209	35
	100		10,000	201	8	4,210	27	4,470	208	29
	80		10,000	201	8	3,680	22	3,860	207	23
	60		10,000	201	8	3,160	17	3,260	207	17
	40		5,000	202	4	2,630	11	2,670	206	12
	20		S.L.	205	–	2,080	6	2,080	205	6
DRAG INDEX = 150	200	190 to 0.45	10,000	198	7	7,270	53	7,950	213	56
	180		10,000	198	7	6,670	48	7,270	212	51
	160		10,000	198	7	6,080	43	6,590	211	45
	140		10,000	198	7	5,500	38	5,930	211	40
	120		10,000	198	7	4,940	33	5,270	210	34
	100		10,000	198	7	4,380	27	4,620	209	29
	80		10,000	198	7	3,820	22	3,980	208	23
	60		10,000	198	7	3,260	17	3,350	207	17
	40		5,000	202	4	2,700	11	2,730	207	12
	20		S.L.	206	–	2,110	6	2,110	206	6

DATA BASED ON:

1. INITIAL ALTITUDE IS SEA LEVEL
2. MILITARY THRUST CLIMB TO INDICATED ALTITUDE
3. 200 KCAS IDLE THRUST DESCENT TO SEA LEVEL (SPEEDBRAKE RETRACTED)
4. FUEL REQUIRED INCLUDES 1500 POUNDS RESERVE FUEL
5. WEIGHT = ZERO FUEL WEIGHT

18AC-NFM-00-(149)

Figure 11-26. Bingo

PART 5 - ENDURANCE

Refer to A1–F18AC–NFM–100.

PART 6 - IN-FLIGHT REFUELING

To be supplied.

PART 7 - DESCENT

Refer to A1–F18AC–NFM–100.

PART 8 - LANDING

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Landing Distance 11-46

LANDING APPROACH SPEED CHART

The landing Approach Speed chart (figure 11-27) provides recommended approach speeds for various gross weights of the aircraft. The data are based on having the speed brake in and the trailing edge flaps deflected 30° or 45°.

USE

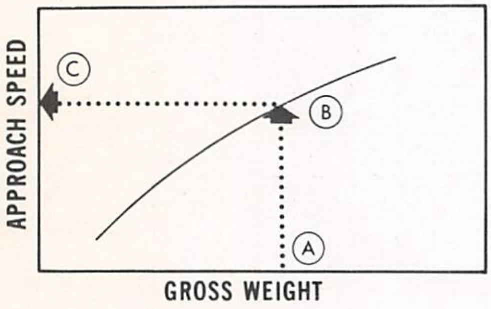
Enter the chart at the estimated landing gross weight and project vertically up to the appropriate flap deflection curve. From this point, project horizontally left to read recommended approach speed.

Sample Problem

Configuration: Flaps 45°

A. Estimated landing gross weight	32,000
B. Flaps 45° curve	
C. Recommended approach speed	135 Kt

SAMPLE LANDING APPROACH SPEED



18AC–NFM–00–(20)

LANDING DISTANCE CHART

This chart (figure 11–28) provides landing roll distance information for a dry hard runway and for various gross weights on a wet runway. The data are for a normal landing using full anti-skid braking after brake limit velocity is reached. Variables of temperature, pressure altitude, gross weight and effective wind are taken into consideration.

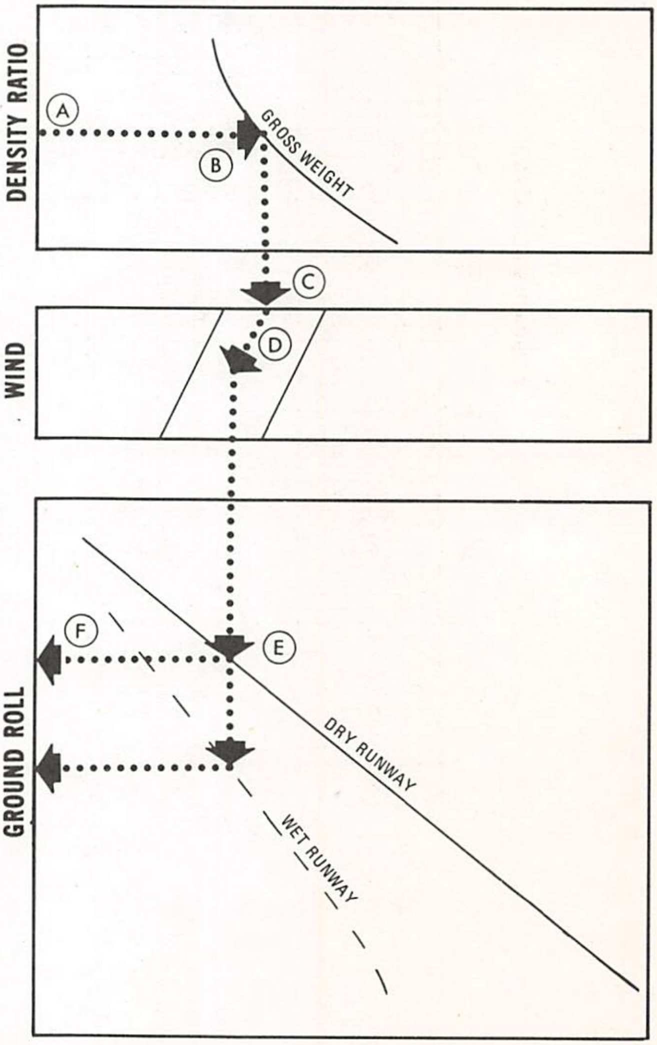
USE

Enter the chart with the prevailing density ratio and project horizontally right to intersect the appropriate gross weight curve. From this point, project vertically down to the wind baseline. Parallel the nearest guideline down to the effective headwind or tailwind. From this point project vertically down to read landing ground roll. To determine total distance required from a height of 50 feet, add 715 feet.

Sample Problem

A. Density ratio	0.94
B. Gross weight	30,000 Lb
C. Wind baseline	
D. Effective headwind	10 Kt
E. Runway condition	Dry
F. Landing distance	2500 Ft
G. Distance required from a height of 50 feet (F + 715)	3215 Ft

SAMPLE LANDING DISTANCE



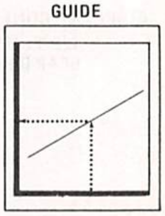
18AC–NFM–00–(21)B

LANDING APPROACH SPEED

AIRPLANE CONFIGURATION
T. E. FLAPS AS NOTED
GEAR DOWN
SPEED BRAKE IN

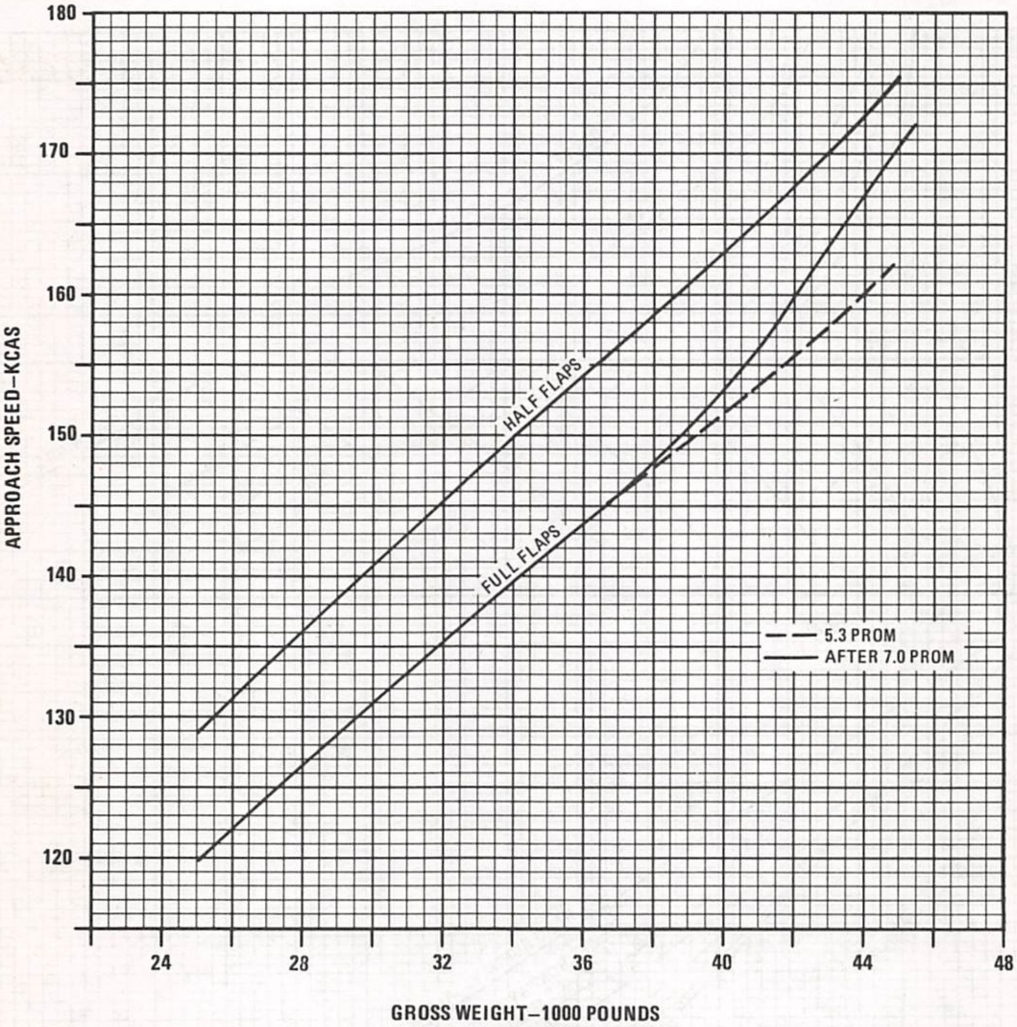
REMARKS
ENGINE (S): (S) F404–GE–400
U. S. STANDARD DAY, 1962

NOTE
AOA 8.1° CG AT 25% MAC. APPROACH SPEED INCREASES 1 KNOT FOR EACH 2% THE CG IS FORWARD OF 25% MAC, AND DECREASES 1 KNOT FOR EACH 2% THE CG IS AFT OF 25% MAC.



DATE: 1 MARCH 1983
DATA BASIS: **FLIGHT TEST**

FUEL GRADE: JP–5
FUEL DENSITY: 6.8 LB/GAL



18AC–NFM–00–(34)B

Figure 11–27. Landing Approach Speed

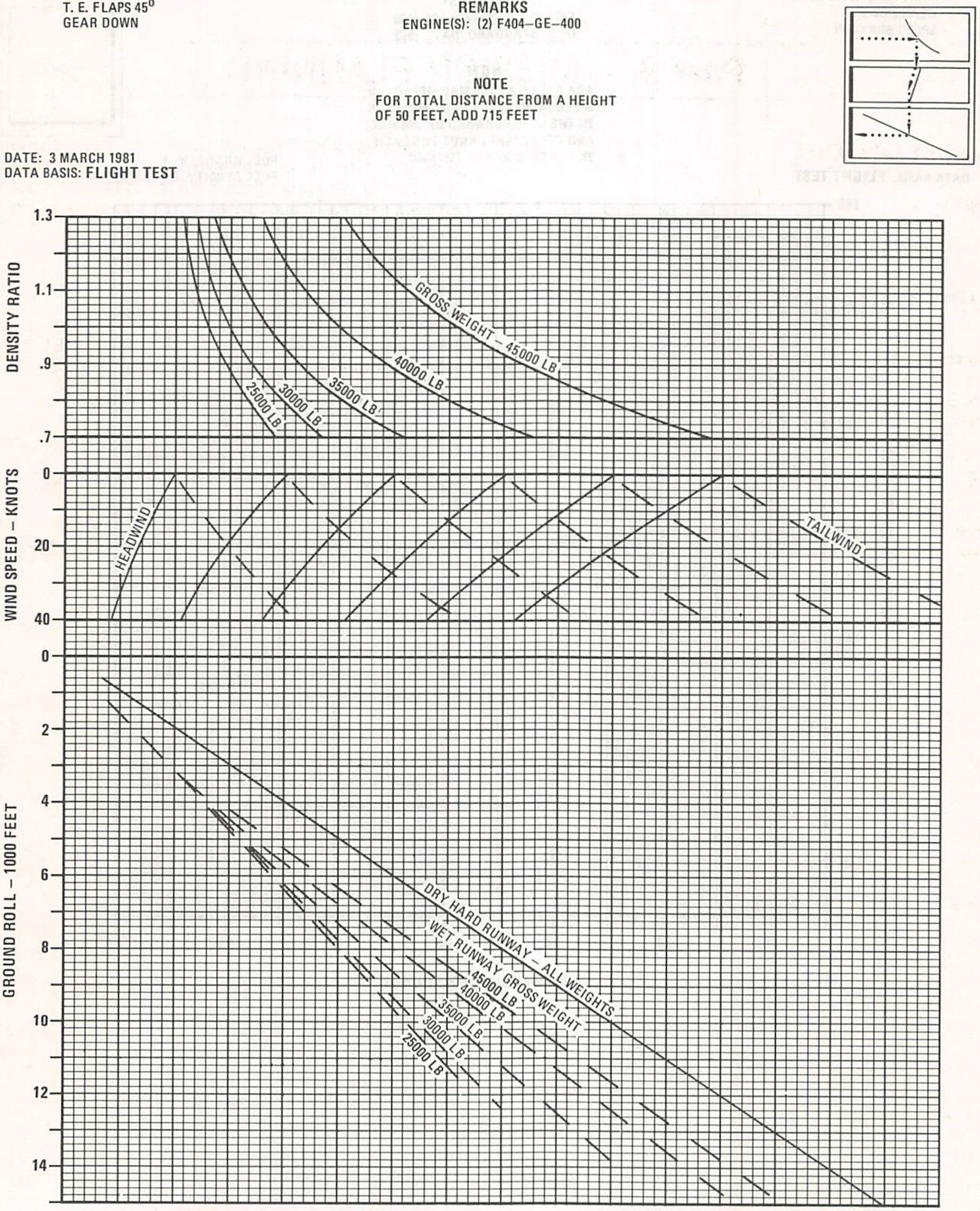
LANDING DISTANCE
IDLE THRUST

AIRPLANE CONFIGURATION
T. E. FLAPS 45°
GEAR DOWN

REMARKS
ENGINE(S): (2) F404-GE-400

NOTE
FOR TOTAL DISTANCE FROM A HEIGHT OF 50 FEET, ADD 715 FEET

DATE: 3 MARCH 1981
DATA BASIS: **FLIGHT TEST**



18AC–NFM–00–(33)A

Figure 11-28. Landing Distance

Part 9 - MISSION PLANNING

TABLE OF CONTENTS

Charts

Turn Capabilities 11-48

TURN CAPABILITIES

This chart (figure 11-29) presents the radius of turn and the rate of turn for a constant altitude, constant speed turn. Turn data is available for various speeds and bank angles. Load factor is also included for each bank angle.

USE

Enter the radius of turn plot with the true airspeed. Proceed horizontally to the right to the desired bank angle. Note the load factor, then proceed vertically downward and read the radius of turn. Enter the rate of turn plot with the true airspeed. Proceed horizontally to the right to the bank angle, note the load factor and then proceed vertically downward to read the rate of turn.

Sample Problem

Radius of Turn

A. True airspeed	420 Kt
B. Bank angle	60°
C. Load factor	2.0 G
D. Radius of Turn	9000 Ft

Rate of Turn

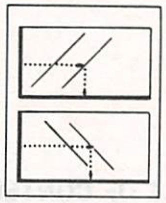
A. True airspeed	420 Kt
B. Bank angle	60°
C. Load factor	2.0 G
D. Rate of turn	4.5°/sec

TURN CAPABILITIES

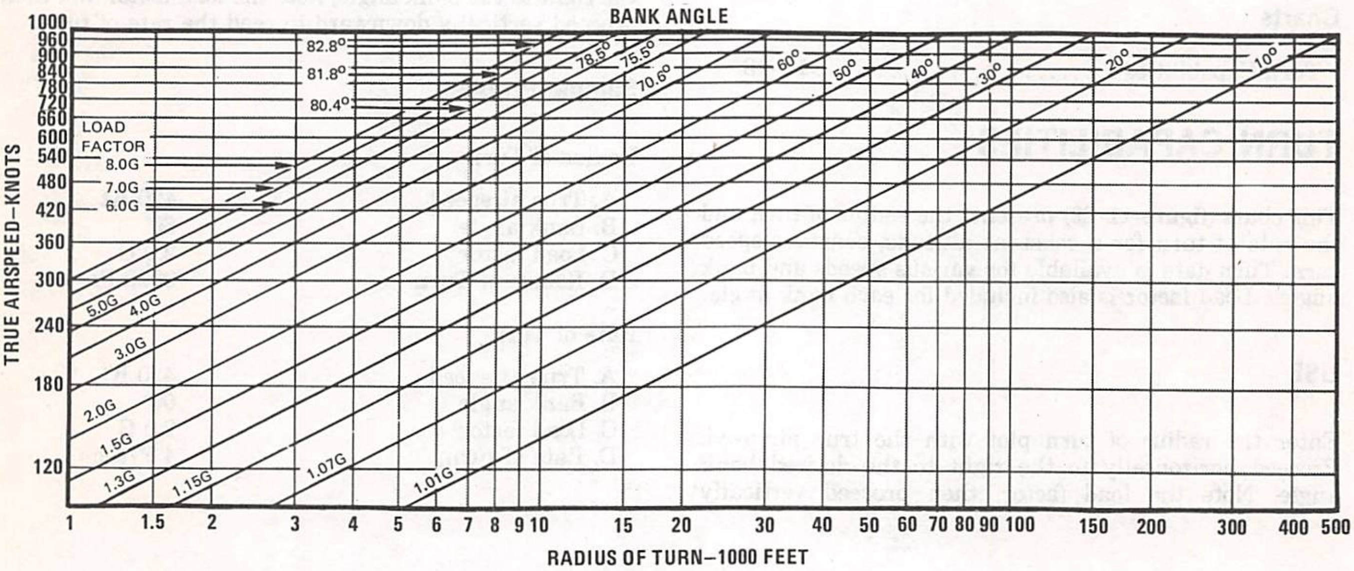
CONSTANT SPEED AND ALTITUDE

REMARKS
ENGINE(S) (2) F404–GE–400
ICAO STANDARD DAY

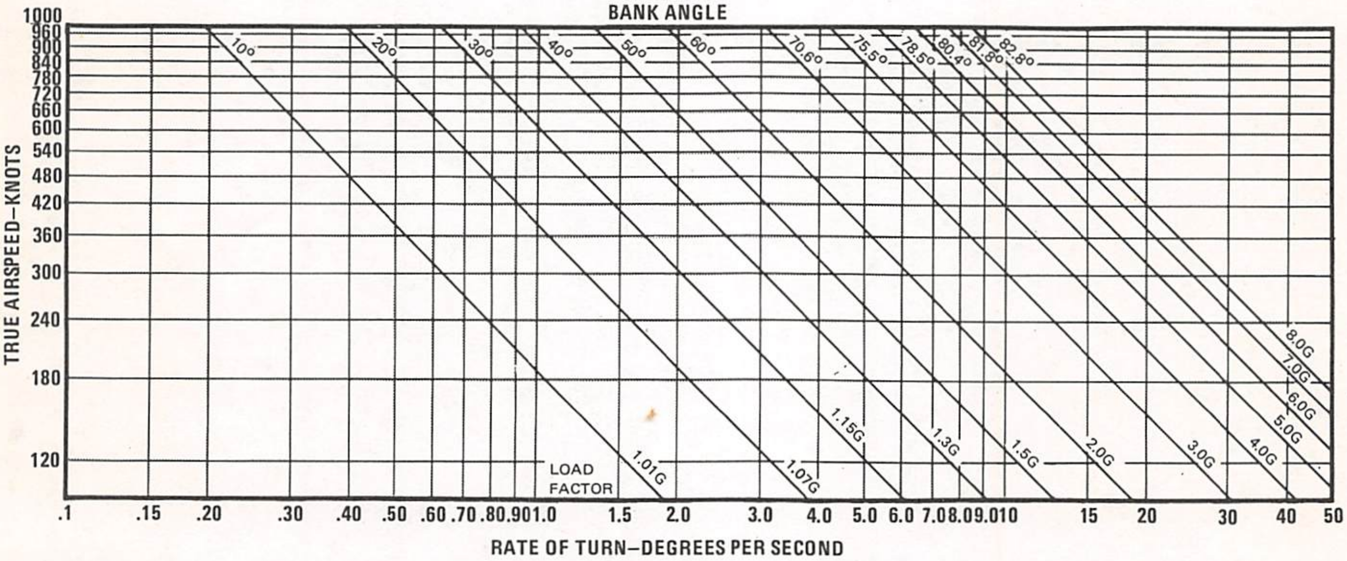
GUIDE



RADIUS OF TURN



RATE OF TURN



18AC–NFM–00–(109)

Figure 11-29. Turn Capabilities

PART 10 - EMERGENCY OPERATION

To be supplied.

APPENDIX

SYSTEM ORGANIZATIONAL MAINTENANCE MANUALS.

The list below contains the publication numbers and titles of the manuals that provide organizational maintenance data by system. This list does not include supplements. The respective manual introduction has information on supplements.

Principles of Operation A1–F18AC	System Schematics A1–F18AC	System Title
–120–100	–120–500	Seat, Canopy, Survival Equipment, and Boarding Ladder
–130–100	–130–500	Landing Gear and Related Systems
–240–100	–240–500	Secondary Power System
–270–100	–270–500	Power Plant and Related Systems
–410–100	–410–500	Environmental Control Systems
–420–100	–420–500	Electrical System
–440–100	–440–500	Lighting System
–450–100	–450–500	Hydraulic System
–460–100	–460–500	Fuel System
–510–100	–510–500	Instrument Systems
–560–100	–560–500	Air Data Computer System
–570–100	–570–500	Integrated Flight Controls
–580–100	–580–500	Maintenance Status Display and Recording System
–600–100	–600–500	Communication, TACAN, ADF, Electronic Altimeter, and IFF Systems
–630–100	–630–500	Data Link, Instrument Landing, and Radar Beacon Systems
–730–100	–730–500	Inertial Navigation, and Backup Attitude and Navigation Systems
–740–100	–740–500	Weapon Control Systems
–741–100	–741–500	Mission Computer System
–742–100	–742–500	Radar System
–743–100	–743–500	Laser Spot Tracker System
–744–100	–744–500	Forward Looking Infrared System
–745–100	–745–500	Multipurpose Display Group
–750–100	–750–500	Gun System
–760–100	–760–500	Tactical Electronic Warfare Systems
–770–100	–770–500	Photographic System

FOLDOUTS

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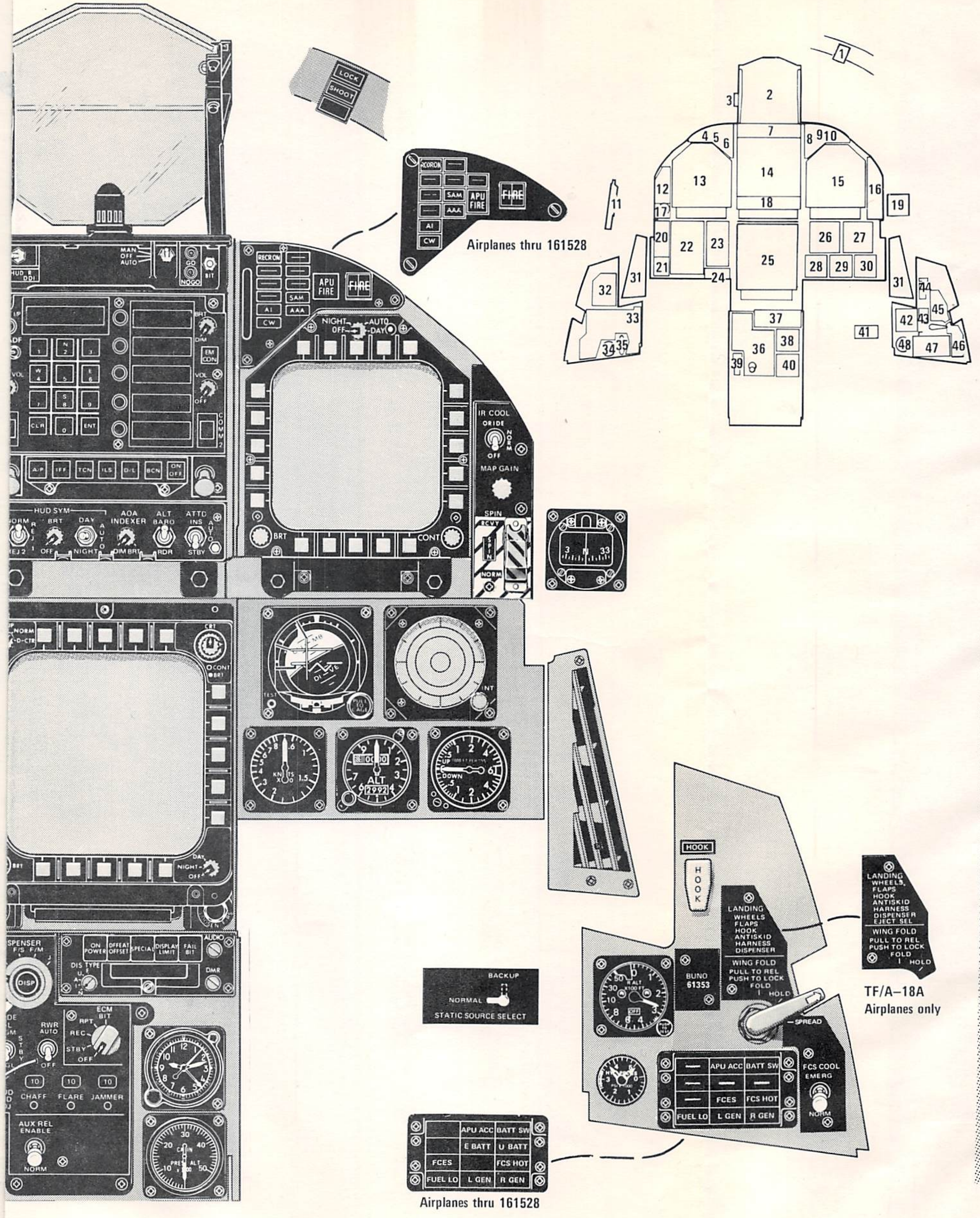
Environmental Control System FO-25
Avionics Subsystems FO-27

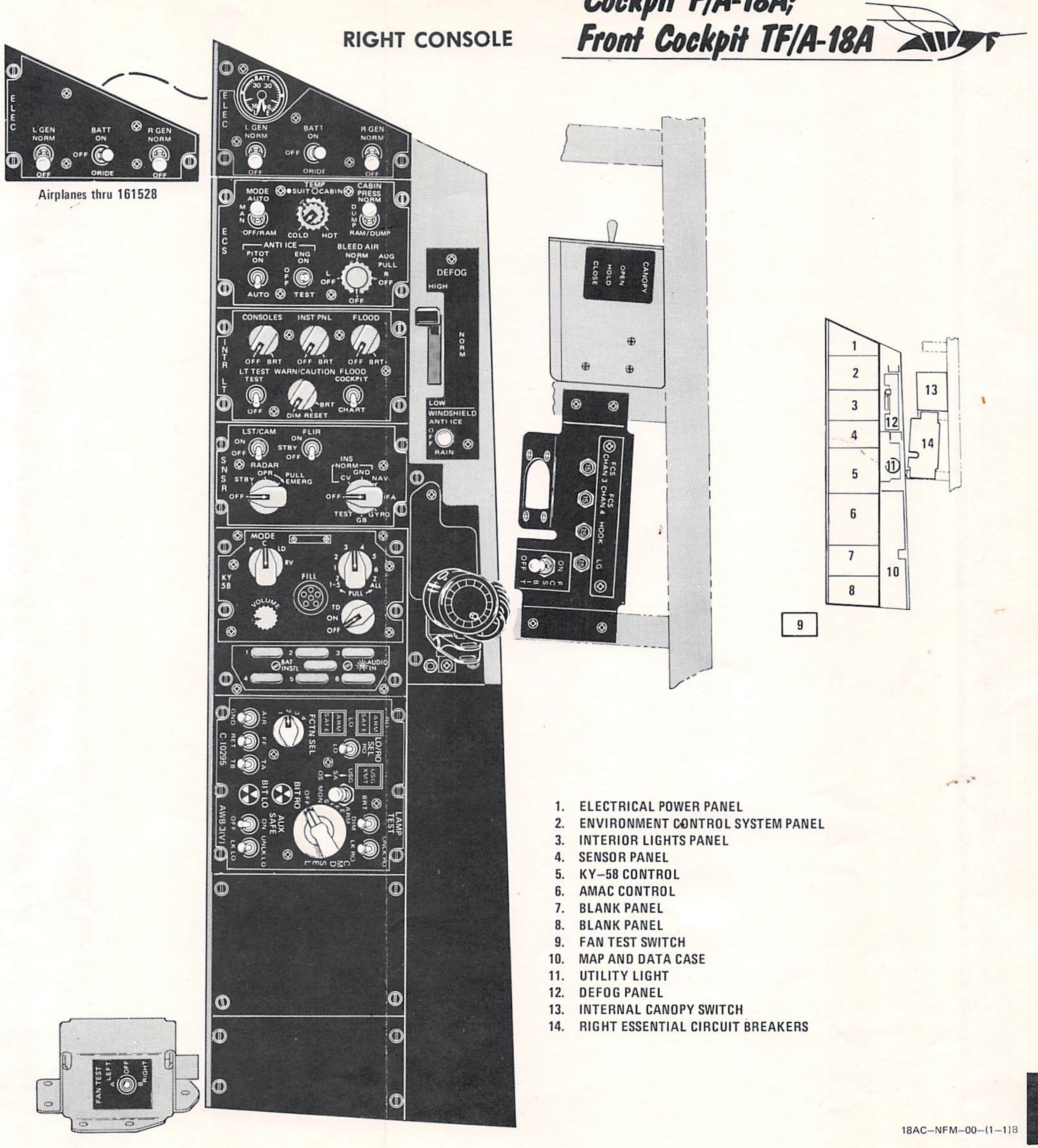
FOLDOUT SECTION

The purpose of the Foldout Section is to make these illustrations available for ready reference while reading the associated text. The illustrations are referenced from several sections of the manual and are referred to in the text as (see figure FO– , foldout section).

Cockpit F/A-18A; Front Cockpit TF/A-18A



RIGHT CONSOLE



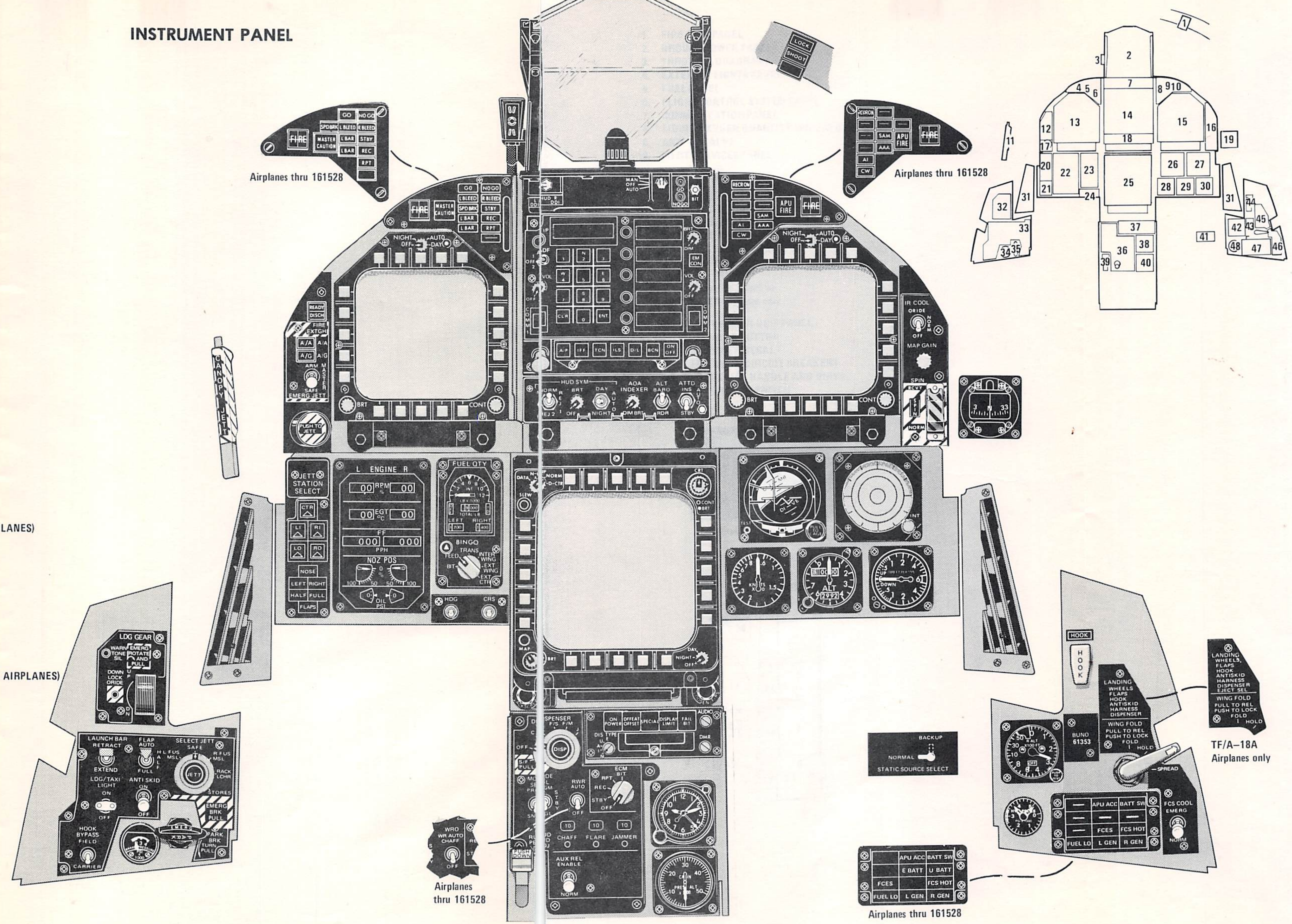
1. ELECTRICAL POWER PANEL
2. ENVIRONMENT CONTROL SYSTEM PANEL
3. INTERIOR LIGHTS PANEL
4. SENSOR PANEL
5. KY–58 CONTROL
6. AMAC CONTROL
7. BLANK PANEL
8. BLANK PANEL
9. FAN TEST SWITCH
10. MAP AND DATA CASE
11. UTILITY LIGHT
12. DEFOG PANEL
13. INTERNAL CANOPY SWITCH
14. RIGHT ESSENTIAL CIRCUIT BREAKERS

18AC–NFM–00–(1–1)B

Figure FO-1. Cockpit F/A-18A; Front Cockpit TF/A-18A (Sheet 1 of 2)

INSTRUMENT PANEL

1. LOCK SHOOT LIGHTS
2. HEAD UP DISPLAY (HUD)
3. ANGLE OF ATTACK INDEXER LIGHTS
4. LEFT ENGINE FIRE WARNING/EXTINGUISHER LIGHT
5. MASTER CAUTION LIGHT
6. LEFT WARNING/CAUTION/ADVISORY LIGHTS
7. HUD VIDEO CAMERA CONTROL
8. RIGHT WARNING/CAUTION/ADVISORY LIGHTS
9. AUXILIARY POWER UNIT FIRE WARNING/EXTINGUISHER LIGHT
10. RIGHT ENGINE FIRE WARNING/EXTINGUISHER LIGHT
11. CANOPY INTERNAL JETTISON HANDLE
12. MASTER ARM PANEL
13. LEFT DIGITAL DISPLAY INDICATOR (DDI)
14. UPFRONT CONTROL PANEL
15. RIGHT DIGITAL DISPLAY INDICATOR (DDI)
16. MAP GAIN/SPIN RECOVERY PANEL
17. EMERGENCY JETTISON BUTTON
18. HUD CONTROL
19. STANDBY MAGNETIC COMPASS
20. STATION JETTISON SELECT
21. LANDING GEAR AND FLAP POSITION LIGHTS
22. ENGINE MONITOR INDICATOR (EMI)
    - L & R RPM
    - L & R EGT
    - L & R FUEL FLOW
    - L & R NOZZLE POSITION
    - L & R OIL PRESSURE
23. FUEL QUANTITY INDICATOR
24. HEADING AND COURSE SET SWITCHES
25. HORIZONTAL INDICATOR (HI)
26. ATTITUDE REFERENCE INDICATOR
27. AZIMUTH INDICATOR; BLANK PANEL (SOME AIRPLANES)
28. STANDBY AIRSPEED INDICATOR
29. STANDBY ALTIMETER
30. STANDBY RATE OF CLIMB INDICATOR
31. ENVIRONMENT CONTROL LOUVERS
32. LANDING GEAR HANDLE AND WARNING TONE SILENCE BUTTON
33. SELECT JETTISON BUTTON
34. BRAKE ACCUMULATOR PRESSURE GAGE
35. EMERGENCY AND PARKING BRAKE HANDLE
36. DISPENSER/ECM PANEL
37. RWR CONTROL INDICATOR; BLANK PANEL (SOME AIRPLANES)
38. CLOCK
39. RUDDER PEDAL ADJUST LEVER
40. COCKPIT ALTIMETER
41. STATIC SOURCE SELECT
42. RADAR ALTIMETER
43. AIRCRAFT BUREAU NUMBER
44. ARRESTING HOOK HANDLE AND LIGHT
45. LANDING CHECKLIST AND WING FOLD SWITCH
46. FLIGHT COMPUTER COOL SWITCH
47. CAUTION LIGHTS PANEL
48. HYD 1 AND HYD 2 PRESSURE INDICATOR



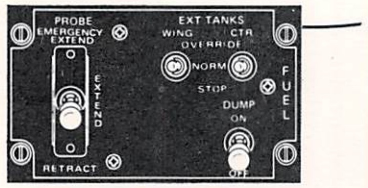
LEFT CONSOLE

1. FIRE TEST PANEL
2. GROUND POWER PANEL
3. THROTTLE QUADRANT
4. EXTERIOR LIGHTS PANEL
5. FUEL PANEL
6. FLIGHT CONTROL SYSTEM PANEL
7. COMMUNICATION PANEL
8. LIQUID OXYGEN QUANTITY INDICATOR
9. ANTI–G VALVE
10. PILOT SERVICES PANEL
    - ANTI–G
    - SUIT VENT
    - OXYGEN
11. COMMUNICATION CONNECTION
12. MISSION COMPUTER AND HYDRAULIC ISOLATE PANEL
13. ANTENNA SELECT PANEL

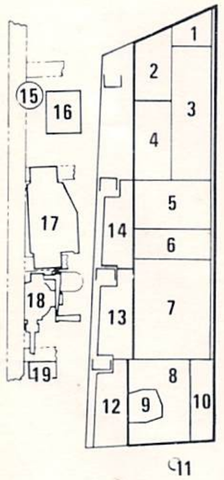
NOTE

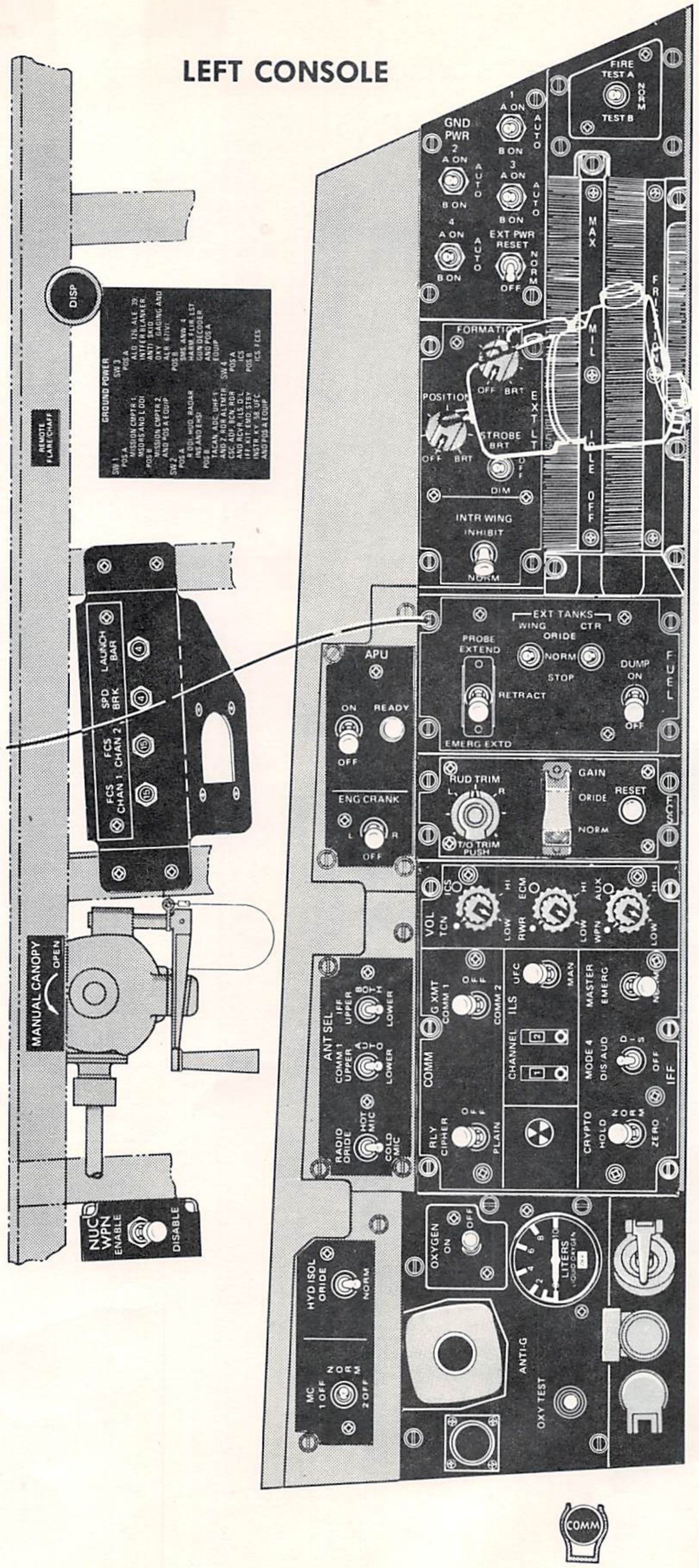
Radio override switch on TF/A–18A airplanes only

14. AUXILIARY POWER UNIT PANEL
15. ECM DISPENSER BUTTON
16. GROUND POWER DECAL
17. LEFT ESSENTIAL CIRCUIT BREAKERS
18. CANOPY MANUAL HANDLE AND DRIVE
19. NUCLEAR WEAPON SWITCH



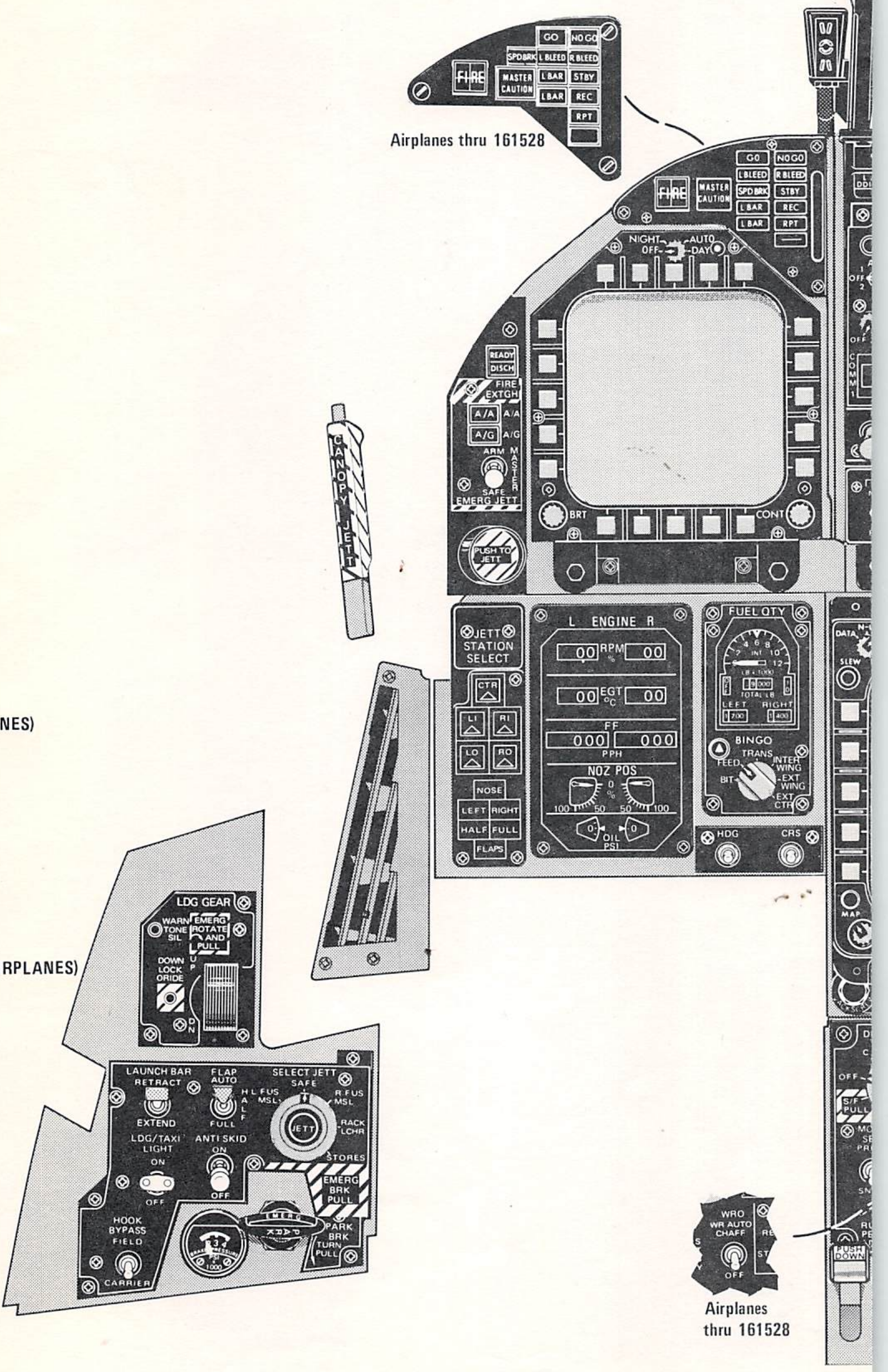
Airplanes thru 161528





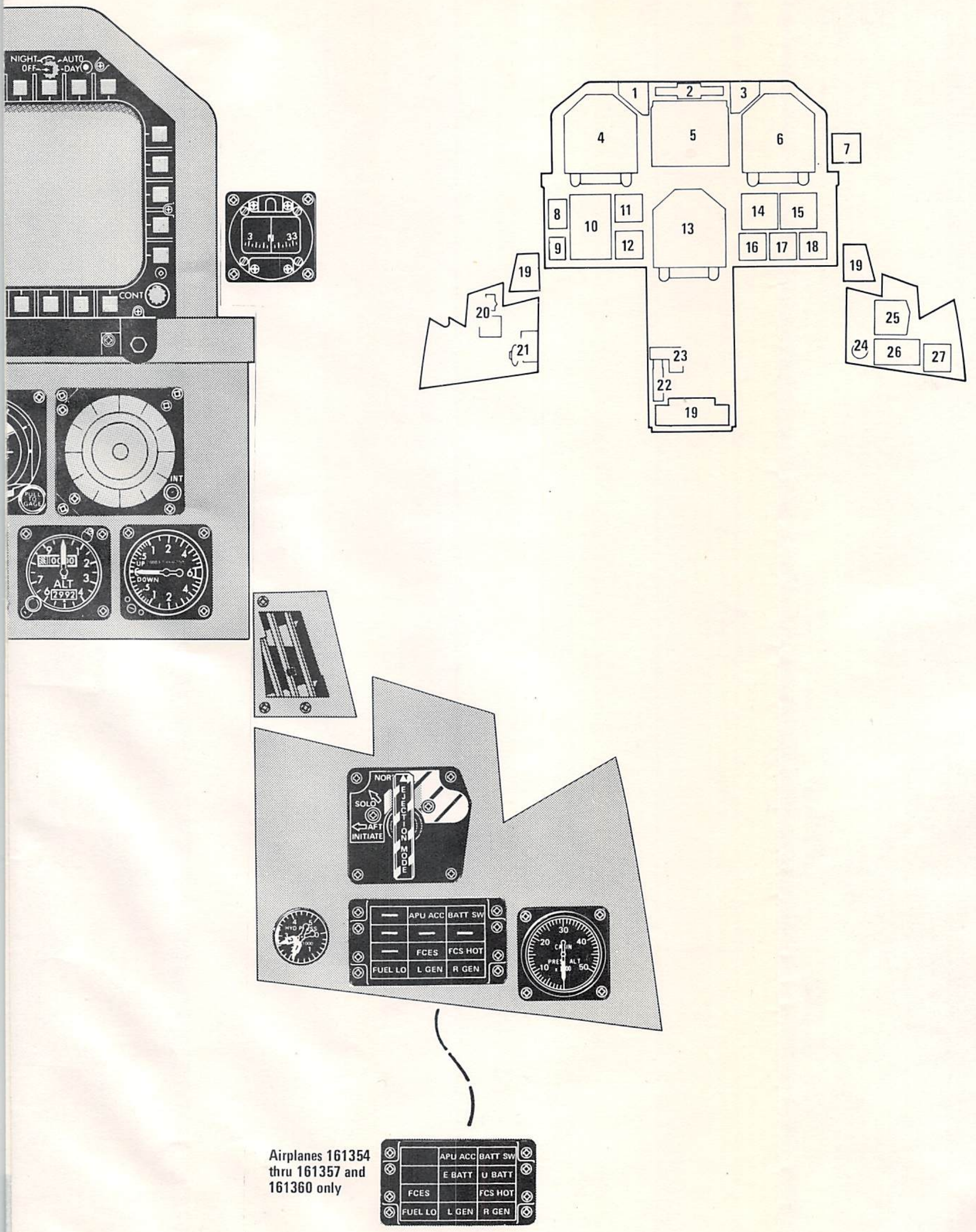
INSTRUMENT PANEL

1. LOCK SHOOT LIGHTS
2. HEAD UP DISPLAY (HUD)
3. ANGLE OF ATTACK INDEXER LIGHTS
4. LEFT ENGINE FIRE WARNING/EXTINGUISHER LIGHT
5. MASTER CAUTION LIGHT
6. LEFT WARNING/CAUTION/ADVISORY LIGHTS
7. HUD VIDEO CAMERA CONTROL
8. RIGHT WARNING/CAUTION/ADVISORY LIGHTS
9. AUXILIARY POWER UNIT FIRE WARNING/EXTINGUISHER LIGHT
10. RIGHT ENGINE FIRE WARNING/EXTINGUISHER LIGHT
11. CANOPY INTERNAL JETTISON HANDLE
12. MASTER ARM PANEL
13. LEFT DIGITAL DISPLAY INDICATOR (DDI)
14. UPFRONT CONTROL PANEL
15. RIGHT DIGITAL DISPLAY INDICATOR (DDI)
16. MAP GAIN/SPIN RECOVERY PANEL
17. EMERGENCY JETTISON BUTTON
18. HUD CONTROL
19. STANDBY MAGNETIC COMPASS
20. STATION JETTISON SELECT
21. LANDING GEAR AND FLAP POSITION LIGHTS
22. ENGINE MONITOR INDICATOR (EMI)
    - L & R RPM
    - L & R EGT
    - L & R FUEL FLOW
    - L & R NOZZLE POSITION
    - L & R OIL PRESSURE
23. FUEL QUANTITY INDICATOR
24. HEADING AND COURSE SET SWITCHES
25. HORIZONTAL INDICATOR (HI)
26. ATTITUDE REFERENCE INDICATOR
27. AZIMUTH INDICATOR; BLANK PANEL (SOME AIRPLANES)
28. STANDBY AIRSPEED INDICATOR
29. STANDBY ALTIMETER
30. STANDBY RATE OF CLIMB INDICATOR
31. ENVIRONMENT CONTROL LOUVERS
32. LANDING GEAR HANDLE AND WARNING TONE SILENCE BUTTON
33. SELECT JETTISON BUTTON
34. BRAKE ACCUMULATOR PRESSURE GAGE
35. EMERGENCY AND PARKING BRAKE HANDLE
36. DISPENSER/ECM PANEL
37. RWR CONTROL INDICATOR; BLANK PANEL (SOME AIRPLANES)
38. CLOCK
39. RUDDER PEDAL ADJUST LEVER
40. COCKPIT ALTIMETER
41. STATIC SOURCE SELECT
42. RADAR ALTIMETER
43. AIRCRAFT BUREAU NUMBER
44. ARRESTING HOOK HANDLE AND LIGHT
45. LANDING CHECKLIST AND WING FOLD SWITCH
46. FLIGHT COMPUTER COOL SWITCH
47. CAUTION LIGHTS PANEL
48. HYD 1 AND HYD 2 PRESSURE INDICATOR



Airplanes thru 161528

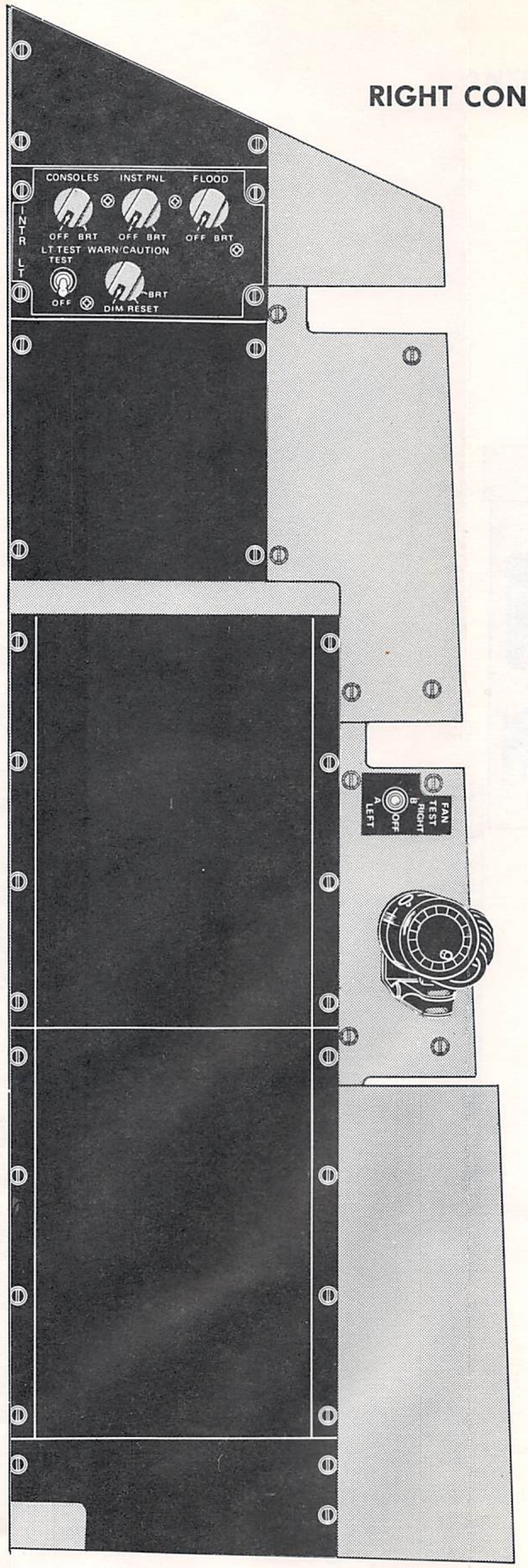
Airplanes thru 161528



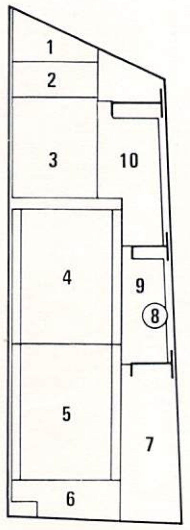
Airplanes 161354
thru 161357 and
161360 only

REAR COCKPIT
TF/A-18A

RIGHT CONSOLE



1. BLANK PANEL
2. INTERIOR LIGHTS PANEL
3. BLANK PANEL
4. BLANK PANEL
5. BLANK PANEL
6. BLANK PANEL
7. MAP AND DATA CASE
8. UTILITY LIGHT
9. FAN TEST SWITCH
10. BLANK PANEL



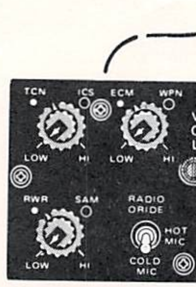
REAR COCKPIT TF/A-18A

18AC–NFM–00–(1–2) A

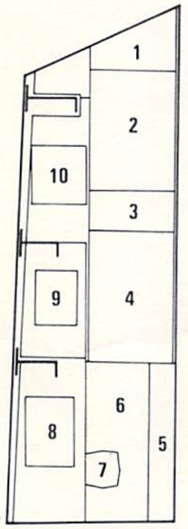
Figure FO-1. Cockpit F/A-18A; Front Cockpit TF/A-18A (Sheet 2)

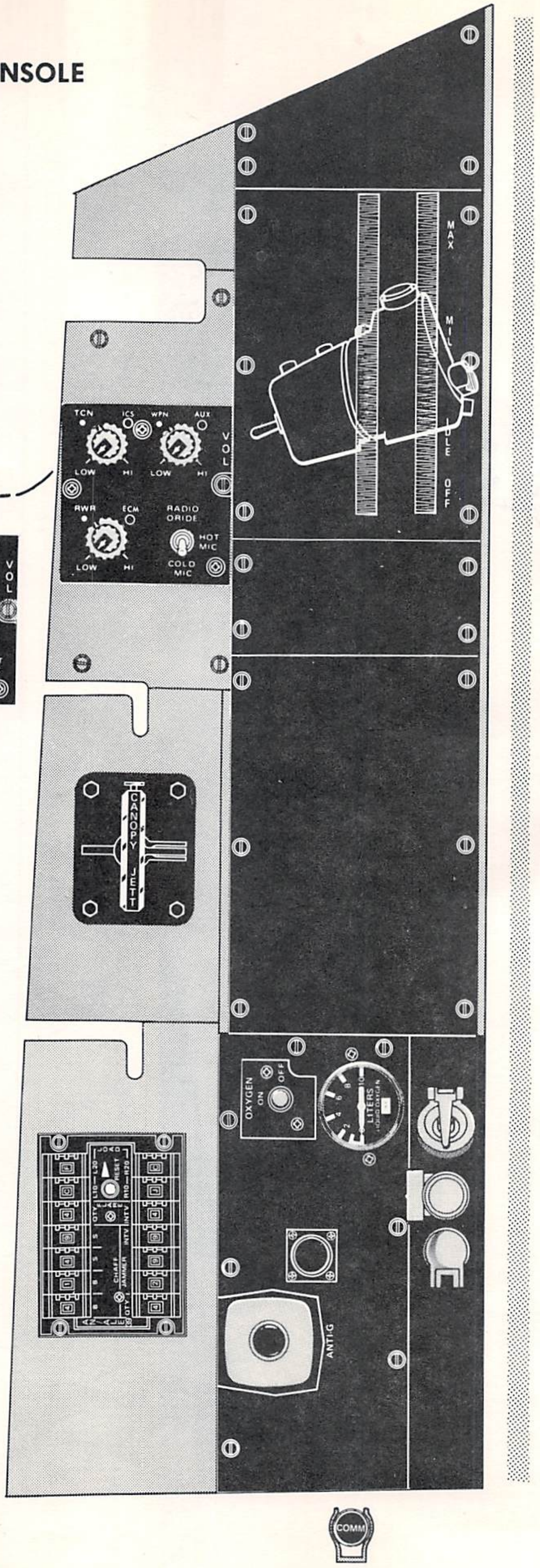
LEFT CONSOLE

1. BLANK PANEL
2. THROTTLE QUADRANT
3. BLANK PANEL
4. BLANK PANEL
5. PILOT SERVICE PANEL
    - ANTI–G
    - SUIT VENT
    - OXYGEN
6. LIQUID OXYGEN QUANTITY
7. ANTI–G VALVE
8. AN/ALE–39 PROGRAMMER
9. CANOPY INTERNAL JETTISON HANDLE
10. VOLUME CONTROL



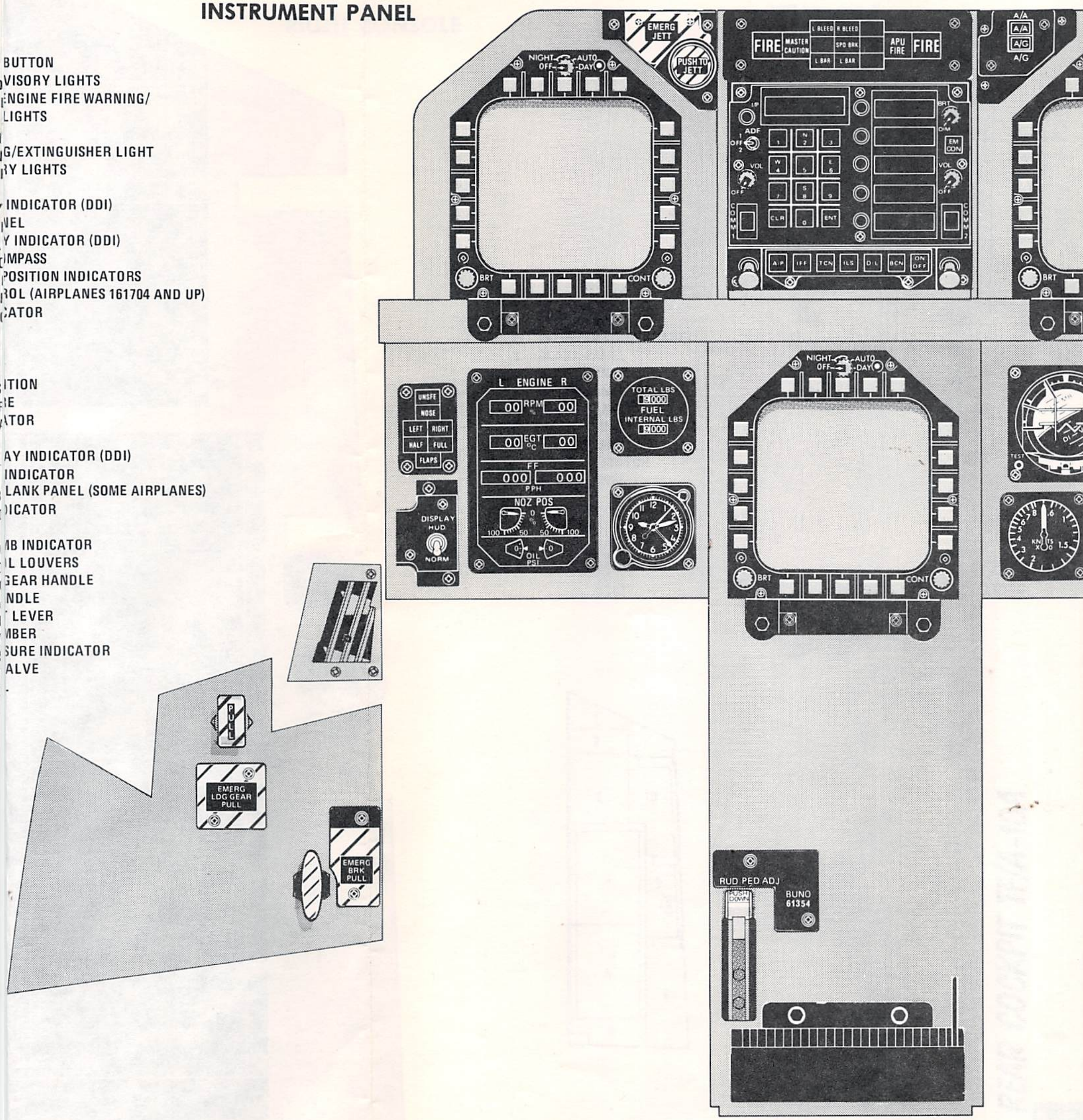
Airplanes 161354 thru 161357 and 161360 only





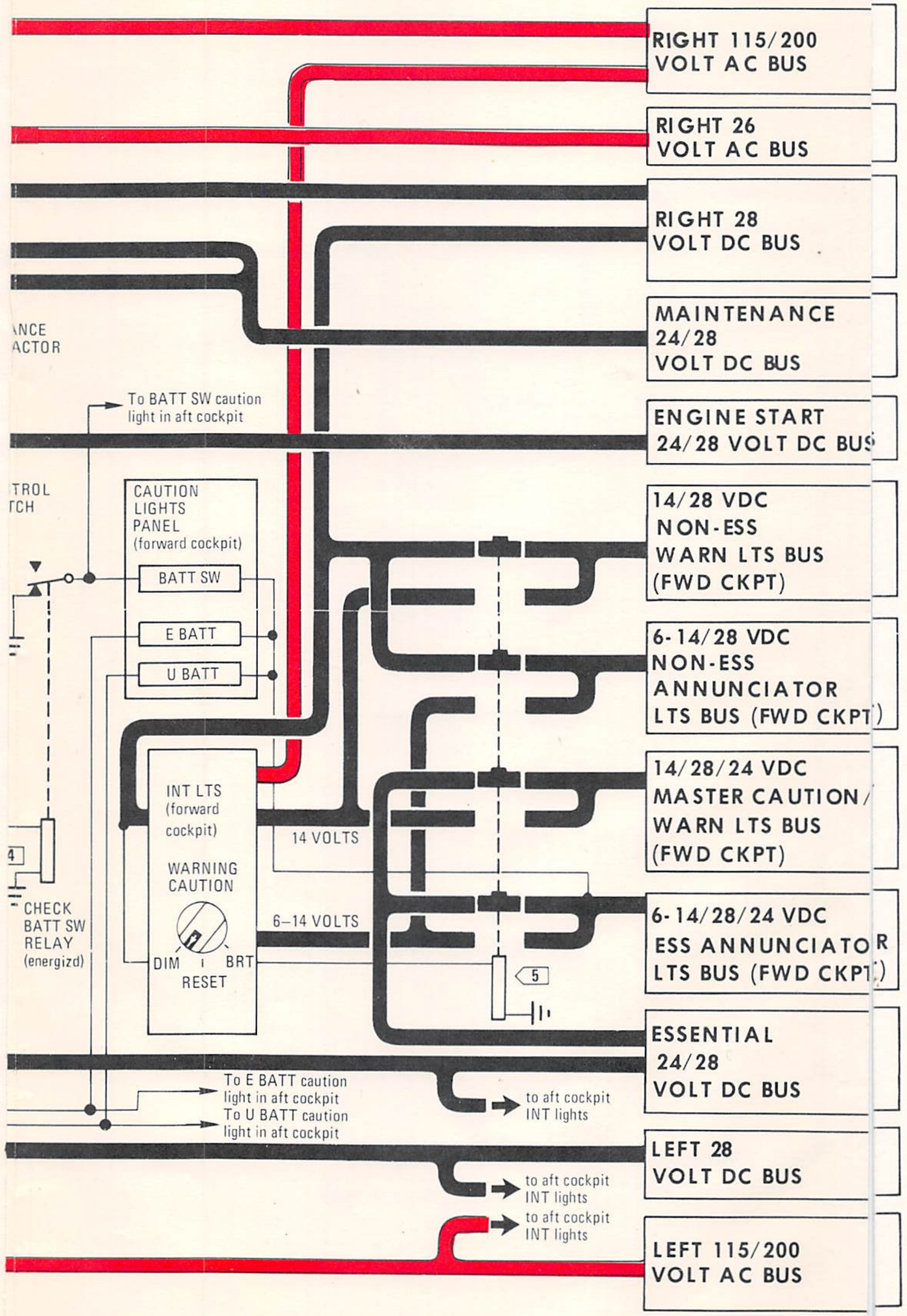
INSTRUMENT PANEL

1. EMERGENCY JETTISON BUTTON
2. WARNING/CAUTION/ADVISORY LIGHTS
    - LEFT AND RIGHT ENGINE FIRE WARNING/ EXTINGUISHER LIGHTS
    - MASTER CAUTION
    - APU FIRE WARNING/EXTINGUISHER LIGHT
    - CAUTION/ADVISORY LIGHTS
3. MASTER MODE PANEL
4. LEFT DIGITAL DISPLAY INDICATOR (DDI)
5. UPFRONT CONTROL PANEL
6. RIGHT DIGITAL DISPLAY INDICATOR (DDI)
7. STANDBY MAGNETIC COMPASS
8. LANDING GEAR/FLAPS POSITION INDICATORS
9. DISPLAY SELECT CONTROL (AIRPLANES 161704 AND UP)
10. ENGINE MONITOR INDICATOR
    - L & R RPM
    - L & R EGT
    - L & R FUEL FLOW
    - L & R NOZZLE POSITION
    - L & R OIL PRESSURE
11. FUEL QUANTITY INDICATOR
12. CLOCK
13. CENTER DIGITAL DISPLAY INDICATOR (DDI)
14. ATTITUDE REFERENCE INDICATOR
15. AZIMUTH INDICATOR; BLANK PANEL (SOME AIRPLANES)
16. STANDBY AIRSPEED INDICATOR
17. STANDBY ALTIMETER
18. STANDBY RATE OF CLIMB INDICATOR
19. ENVIRONMENT CONTROL LOUVERS
20. EMERGENCY LANDING GEAR HANDLE
21. EMERGENCY BRAKE HANDLE
22. RUDDER PEDAL ADJUST LEVER
23. AIRCRAFT BUREAU NUMBER
24. HYD 1 AND HYD 2 PRESSURE INDICATOR
25. COMMAND SELECTOR VALVE
26. CAUTION LIGHTS PANEL
27. COCKPIT ALTIMETER



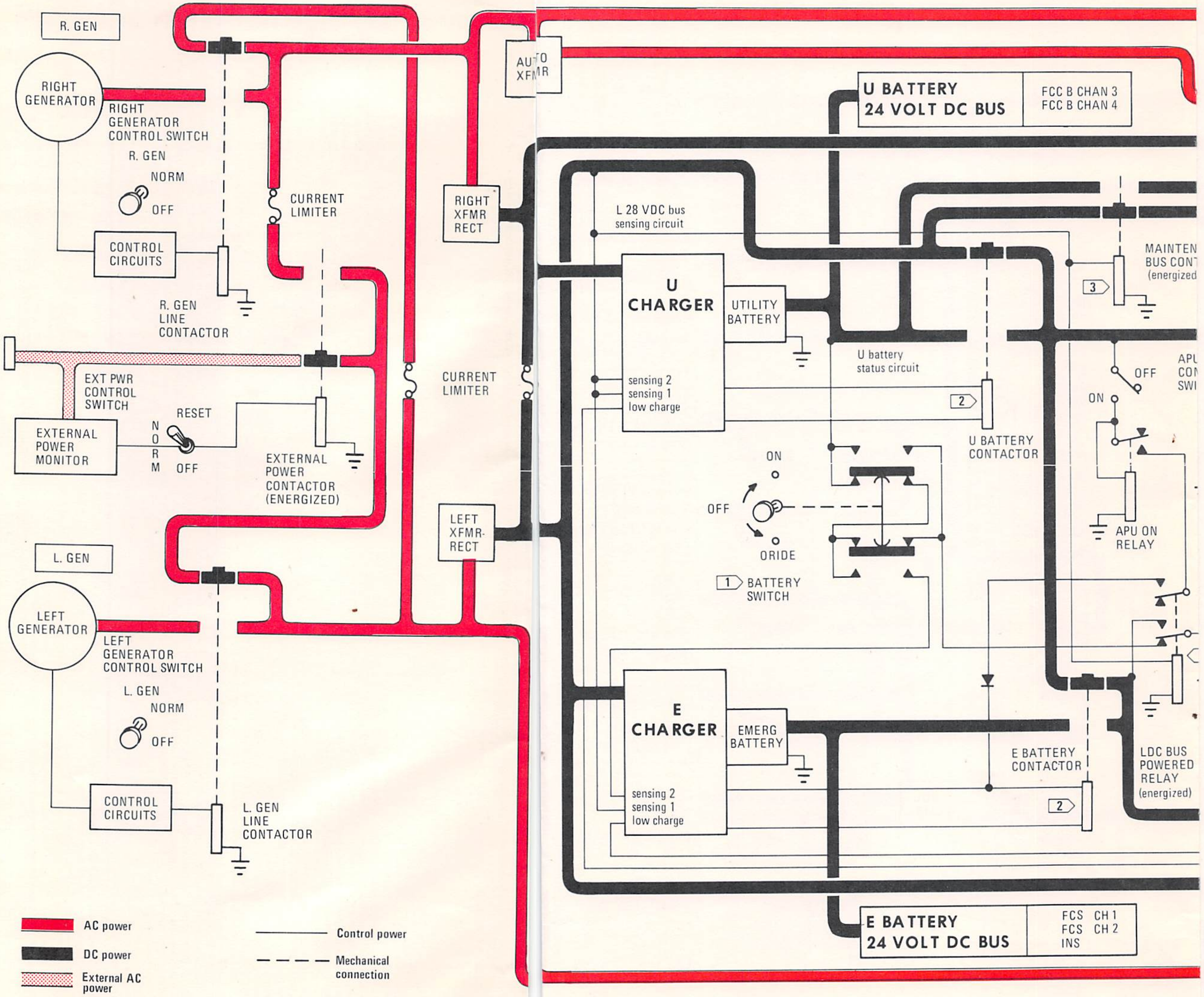
Electrical System

EXTERNAL POWER APPLIED
AIRPLANES 161353 THRU 161528


RIGHT 115/200 VOLT AC BUS
RIGHT 26 VOLT AC BUS
RIGHT 28 VOLT DC BUS
MAINTENANCE 24/28 VOLT DC BUS
ENGINE START 24/28 VOLT DC BUS
14/28 VDC NON-ESS WARN LTS BUS (FWD CKPT)
6-14/28 VDC NON-ESS ANNUNCIATOR LTS BUS (FWD CKPT)
14/28/24 VDC MASTER CAUTION/ WARN LTS BUS (FWD CKPT)
6-14/28/24 VDC ESS ANNUNCIATOR LTS BUS (FWD CKPT)
ESSENTIAL 24/28 VOLT DC BUS
LEFT 28 VOLT DC BUS
LEFT 115/200 VOLT AC BUS
NCE
ACTOR
To BATT SW caution light in aft cockpit
TROL
TCH
CAUTION LIGHTS PANEL (forward cockpit)
BATT SW
E BATT
U BATT
INT LTS (forward cockpit)
WARNING CAUTION
DIM
BRT
RESET
14 VOLTS
6–14 VOLTS
4
5
CHECK BATT SW RELAY (energizd)
To E BATT caution light in aft cockpit
To U BATT caution light in aft cockpit
to aft cockpit INT lights
to aft cockpit INT lights
to aft cockpit INT lights

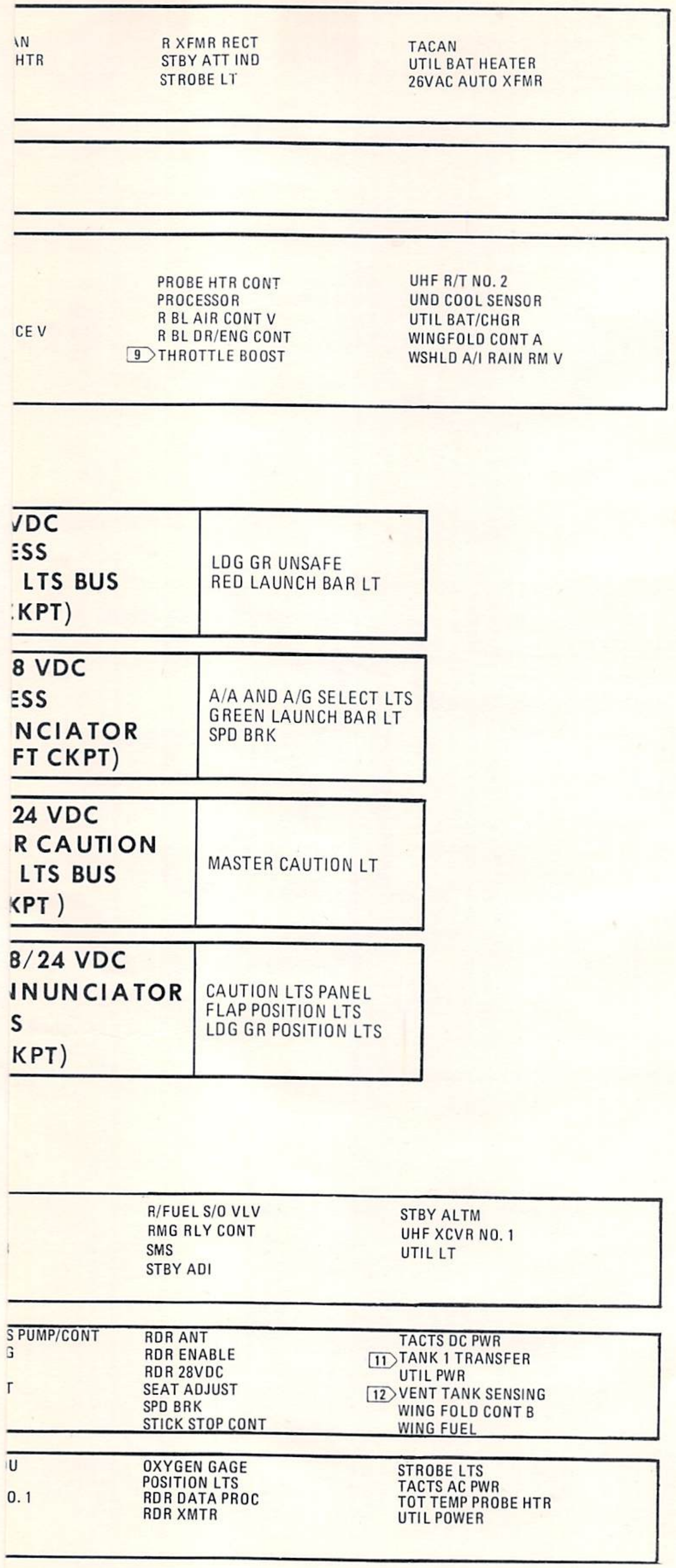
18AC–NFM–00–(52–1)C
R

Figure FO-2. Electrical System (Sheet 1 of 2)


R. GEN
RIGHT GENERATOR
RIGHT GENERATOR CONTROL SWITCH
R. GEN
NORM
OFF
CONTROL CIRCUITS
R. GEN LINE CONTACTOR
CURRENT LIMITER
EXT PWR CONTROL SWITCH
RESET
NORM
OFF
EXTERNAL POWER MONITOR
EXTERNAL POWER CONTACTOR (ENERGIZED)
L. GEN
LEFT GENERATOR
LEFT GENERATOR CONTROL SWITCH
L. GEN
NORM
OFF
CONTROL CIRCUITS
L. GEN LINE CONTACTOR
AUTO XFMR
RIGHT XFMR RECT
CURRENT LIMITER
LEFT XFMR-RECT
U BATTERY 24 VOLT DC BUS
FCC B CHAN 3
FCC B CHAN 4
L 28 VDC bus sensing circuit
U CHARGER
UTILITY BATTERY
sensing 2
sensing 1
low charge
U battery status circuit
2
U BATTERY CONTACTOR
ON
OFF
ORIDE
1
BATTERY SWITCH
MAINTEN
BUS CONT
(energized
3
APU
CON
SWI
OFF
ON
APU ON RELAY
E CHARGER
EMERG BATTERY
sensing 2
sensing 1
low charge
E BATTERY CONTACTOR
2
LDC BUS POWERED RELAY (energized)
E BATTERY 24 VOLT DC BUS
FCS CH 1
FCS CH 2
INS
🟥 AC power
⬛ DC power
▨ External AC power
Control power
Mechanical connection

Electrical System

EXTERNAL POWER APPLIED
AIRPLANES 161353 THRU 161528



NOTE

Nomenclature callouts on the individual buses are circuit breaker nomenclatures. These nomenclatures do not necessarily identify each system powered by the circuit breakers. In exception, the callouts on the lights buses are the lights powered by each bus. Reference to FWD CKPT refers to both F/A–18A and TF/A–18A aircraft. AFT CKPT refers only to TF/A–18A aircraft.

1 Complete battery switch configuration not shown. Missing contacts are those which turn on circuits in the U charger and E charger. These circuits, once turned on, energize the U battery and E battery contactors when sensing circuits 1 and 2 of the respective battery charger both sense a low voltage condition. The U contactor can only be energized with the battery switch in the ON position, and the E contactor can only be energized with the battery switch in either the ON or ORIDE positions. The battery switch is shown in the OFF position. The contacts shown make the following connections for the three switch positions: OFF and ORIDE – U battery status circuit connected to lower contact of left DC bus powered relay; ON– U battery status connected to sensing circuit 2 of E charger.

2 U battery contactor energizes with battery switch in ON and the E battery contactor energizes with battery switch in ON or ORIDE position, and both sensing circuits of the contactors charger sensing a low voltage condition (20.5 volts DC or less). Once energized, a contactor will de–energize only by restoring to a normal level (21.5 volts DC or more) the voltages sensed by both sensing circuits, or by placing the battery switch to the OFF position. The E battery contactor will also energize whenever the APU ON relay is energized (APU operating during engine starts), providing the left 28 volt DC bus is not powered.

3 Maintenance bus contactor energized whenever left 28 volts DC bus is energized, which connects the maintenance 24/28 volt DC to the left 28 volt DC bus. With left 28 volt DC bus de–energized, maintenance contact de–energizes to connect maintenance 24/28 volt DC bus directly to the utility battery.

4 L DC bus powered relay energizes only when power is on the left 28 volts DC bus.

5 Dimming relay shown in the de–energized, or undimmed state. To energize, the warning/caution lights control knob must be placed to the reset position, providing the right 28 volt DC bus (left 28 volt DC bus for AFT CKPT) is energized, the instrument lights panel knob is not in the OFF position, and the flood lights knob is not in the BRT position.

6 With L 28 volt DC bus de–energized, power source for this circuit breaker is switched to the utility battery, providing the battery is charged to at least 16.5 volts.

7 F/A–18A
8 TF/A–18A
9 AIRCRAFT 161353 THRU 161359
10 161353 THRU 161519
11 161520 THRU 161528
12 161353 THRU 161357

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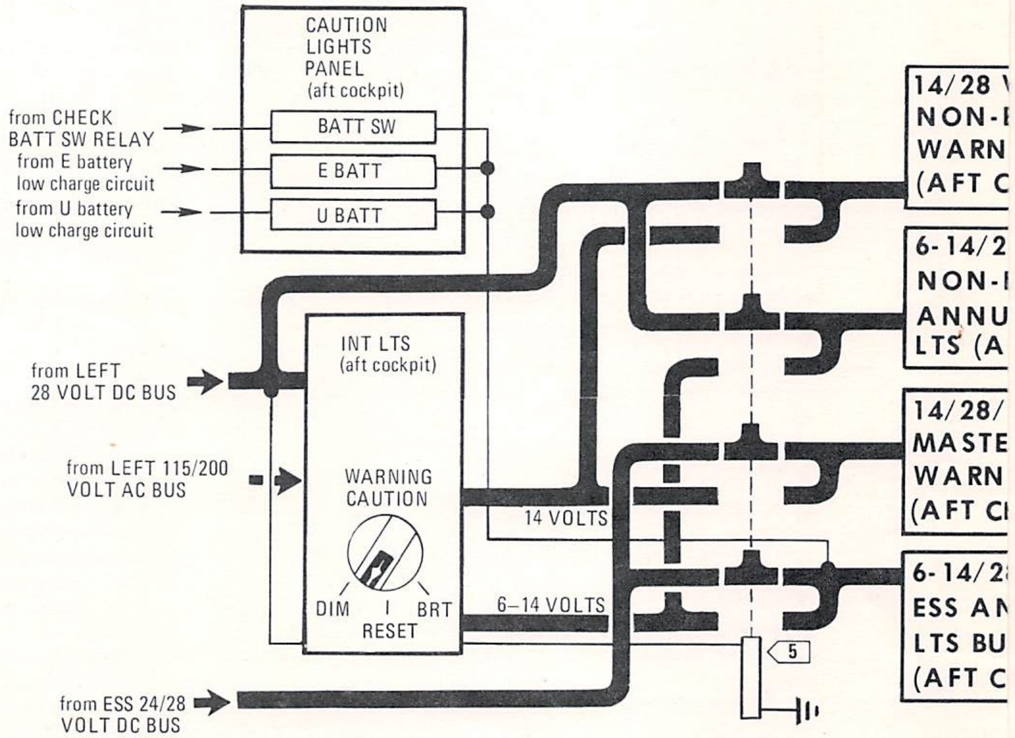
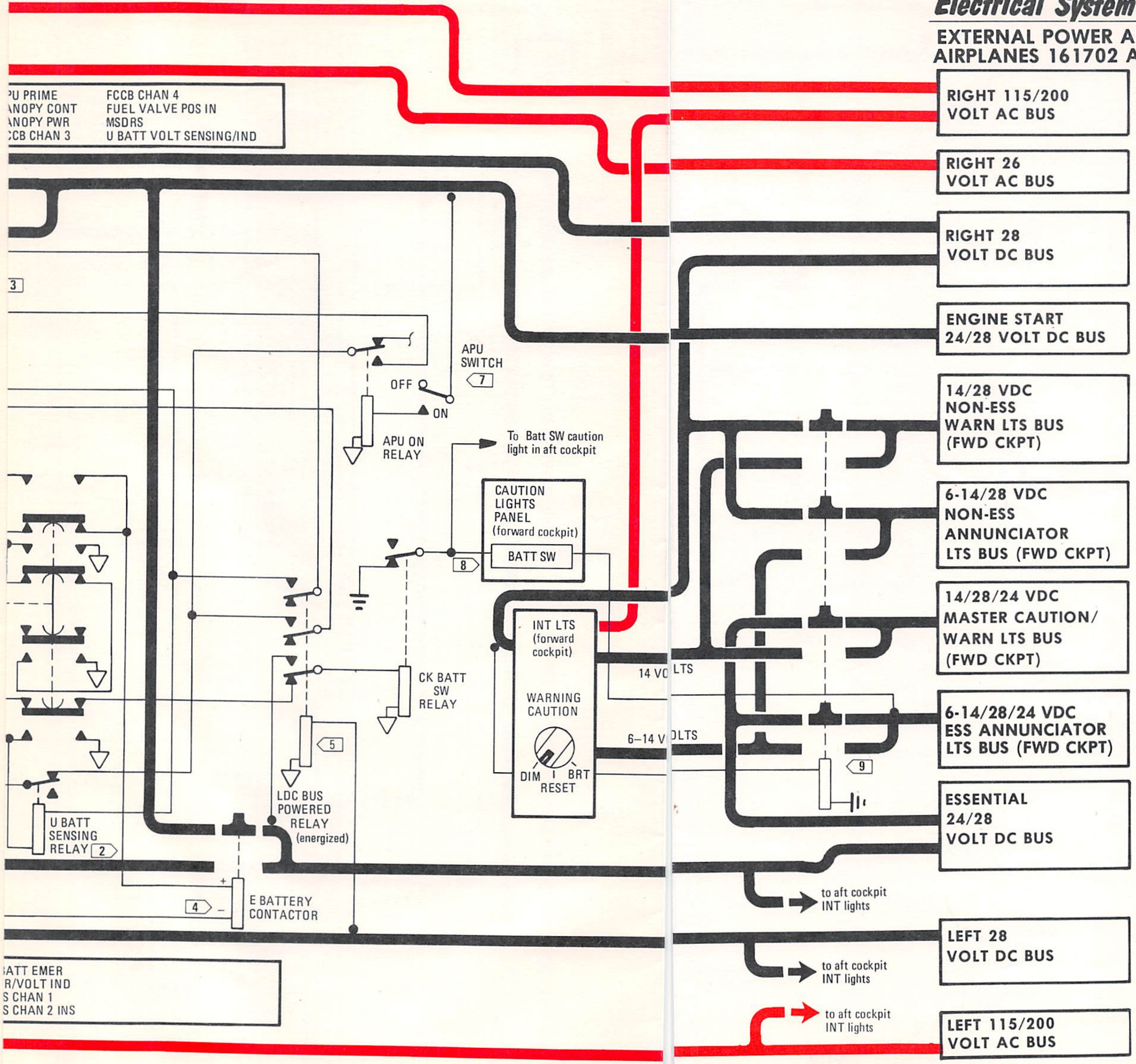
Figure FO-2. Electrical System (Sheet 2)

RIGHT 115/200 VOLT AC BUS	ADC AMAC APRCH LT ARM STA 5 THRU 9 AVIONICS CLG FAN CSC ECS CONT ELEC ALT FUEL QUAN IND HARM CMD LAUNCH CMPTR HUD ICE DETR INTERFERENCE BLANKER INT LTS CONT MFD MISSION CMPTR NO. 2 PROCESSOR R AOA PROBE HTR R BL AIR DR R CABIN CLG F R PITOT PROBE R WING FOLD
RIGHT 26 VOLT AC BUS	ADF HYD SYS NO. 1 HYD SYS NO. 2 INS
RIGHT 28 VOLT DC BUS	ADF AMAC AN ALE 39 CONT AN ALE 39 PWR ANT SEL APC APRCH LT CONT ARM STA 5 THRU 9 ARM STA 7 AERO 5 ARM STA 8 AERO 5 AUG RCVR – BEACON AVIONICS/LCS CLG FAN CONT BLEED AIR CONTROL VALVES CAB CLG FAN CONT CABIN RAM AIR VALVE CSC ECS CONT. ENGINE ANTI–ICE VALVE ENGINE ICE DETR FCS CHAN 3 FCS CHAN 4 GND CLG FANS CONT HARM CMD LAUNCH CMPTR HOOK HUD INTERCOM INT LTS LG LG CONT L/R ENG ANTI– LST/SCAM POD
MAINTENANCE 24/28 VOLT DC BUS	APU PRIME CANOPY PWR FUEL VALVE POS IND MSDRS
ENGINE START 24/28 VOLT DC BUS	ENGINE START APU
14/28 VDC NON-ESS WARN LTS BUS (FWD CKPT)	HOOK LT ELECTRONIC ALT LOW ALT LT 8 > RED LAUNCH BAR LT
6-14/28 VDC NON-ESS ANNUNCIATOR LTS BUS (FWD CKPT)	A/A AND A/G SELECT LTS GREEN LAUNCH BAR LT LOCK AND SHOOT LTS SPD BRK STATION SELECT LTS
14/28/24 VDC MASTER CAUTION/WARN LTS BUS (FWD CKPT)	LDG GR HDL LT MASTER CAUTION LT 7 > RED LAUNCH BAR LT SPIN RECOVERY LT
6-14/28/24 VDC ESS ANNUNCIATOR LTS BUS (FWD CKPT)	APU READY LT CAUTION LTS PANEL FLAP POSITION LTS LOG GR POSITION LTS READY/DISCH LTS
ESSENTIAL 24/28 VOLT DC BUS	ARM STA 2 THRU 6 ASYM BK FCCA BL AIR LEAK DET LOOP A BL AIR LEAK DET LOOP B CAB AIR DUMP VLV CHECK BAT RELAY SW EMER IFR CROSSFEED FUEL VLV ENG MON 10 > FCC A ASYM BRAKE FCES CHAN 1 FCES CHAN 2 FCS RAM AIR DR ACTR FEXT FIRE DET LOOP A FIRE DET LOOP B FUEL DUMP IFF R/T INTERCOM INT LTS LDG GR CONT UNIT L ENG IND LGCU/NG RLY CONT L/FUEL S/O VLV PITCH TRIM PROCESSOR SMS RATIO CHANGER R ENG IND
LEFT 28 VOLT DC BUS	AFT SEAT ADJUST ANTI SKID 9 > APC ARM STA 1 THRU 4 ARM STA 2 THRU 5 ARM STA 3 THRU 5 ASY BK FCC–B BLD AIR DOOR CONT 10 > CANOPY CONT DATA LINK ECM CLG VALVE EJCTR VALVES EMER BAT CHRG ENG IDLE A–B LKOUT EXT FUEL TANKS CONT EXT LTS CONTL 11 > FCC ASYMMETRY BRAKE FUEL LEVEL LOW FUEL PRESSURE FUEL TK PRESS GND PWR CONTL GUN DECODER HYD ISLN PWR IFR PROBE ILS LAUNCH BAR 10 > L ASYMMETRY BRAKE L BL AIR CONTR V L BLEED DOOR/ENG CONT LCS RAM AIR DOOR ACTR LCS RAM AIR/LC LDC BUS SENSIN SPD BRK STICK STOP CON MASTER ARM NWS
LEFT 115/200 VOLT AC BUS	ALQ–126 ARM STA 1 THRU 4 AWW–4 EHSI/HSO (RPTR DISPLAY) EMER BAT HTR FORMATION LTS FORMATION LTS GUN DECODER IFF COMPUTER/TRANSPONDER IFR LTS ILS INS L AOA PROBE HTR L BLEED DOOR L CABIN COOL FAN LCS CLG FAN LCS CLG PUMP LDG/TAXI LT LQUID LEVEL CONT L PITOT PROBE HTR L WING FOLD ED L XFMR RECT MISSION COMP N MMD



Electrical System

EXTERNAL POWER APPLIED AIRPLANES 161702 AND UP



PU PRIME
NOPY CONT
NOPY PWR
CB CHAN 3
FCCB CHAN 4
FUEL VALVE POS IN
MSDRS
U BATT VOLT SENSING/IND
3
APU SWITCH
7
OFF
ON
APU ON RELAY
To Batt SW caution light in aft cockpit
CAUTION LIGHTS PANEL (forward cockpit)
BATT SW
8
INT LTS (forward cockpit)
WARNING CAUTION
DIM
BRT
RESET
14 VOLTS
6-14 VOLTS
CK BATT SW RELAY
5
LDC BUS POWERED RELAY (energized)
U BATT SENSING RELAY
2
4
+
-
E BATTERY CONTACTOR
ATT EMER
R/VOLT IND
S CHAN 1
S CHAN 2 INS
9
RIGHT 115/200 VOLT AC BUS
RIGHT 26 VOLT AC BUS
RIGHT 28 VOLT DC BUS
ENGINE START 24/28 VOLT DC BUS
14/28 VDC NON-ESS WARN LTS BUS (FWD CKPT)
6-14/28 VDC NON-ESS ANNUNCIATOR LTS BUS (FWD CKPT)
14/28/24 VDC MASTER CAUTION/ WARN LTS BUS (FWD CKPT)
6-14/28/24 VDC ESS ANNUNCIATOR LTS BUS (FWD CKPT)
ESSENTIAL 24/28 VOLT DC BUS
to aft cockpit INT lights
LEFT 28 VOLT DC BUS
to aft cockpit INT lights
to aft cockpit INT lights
LEFT 115/200 VOLT AC BUS

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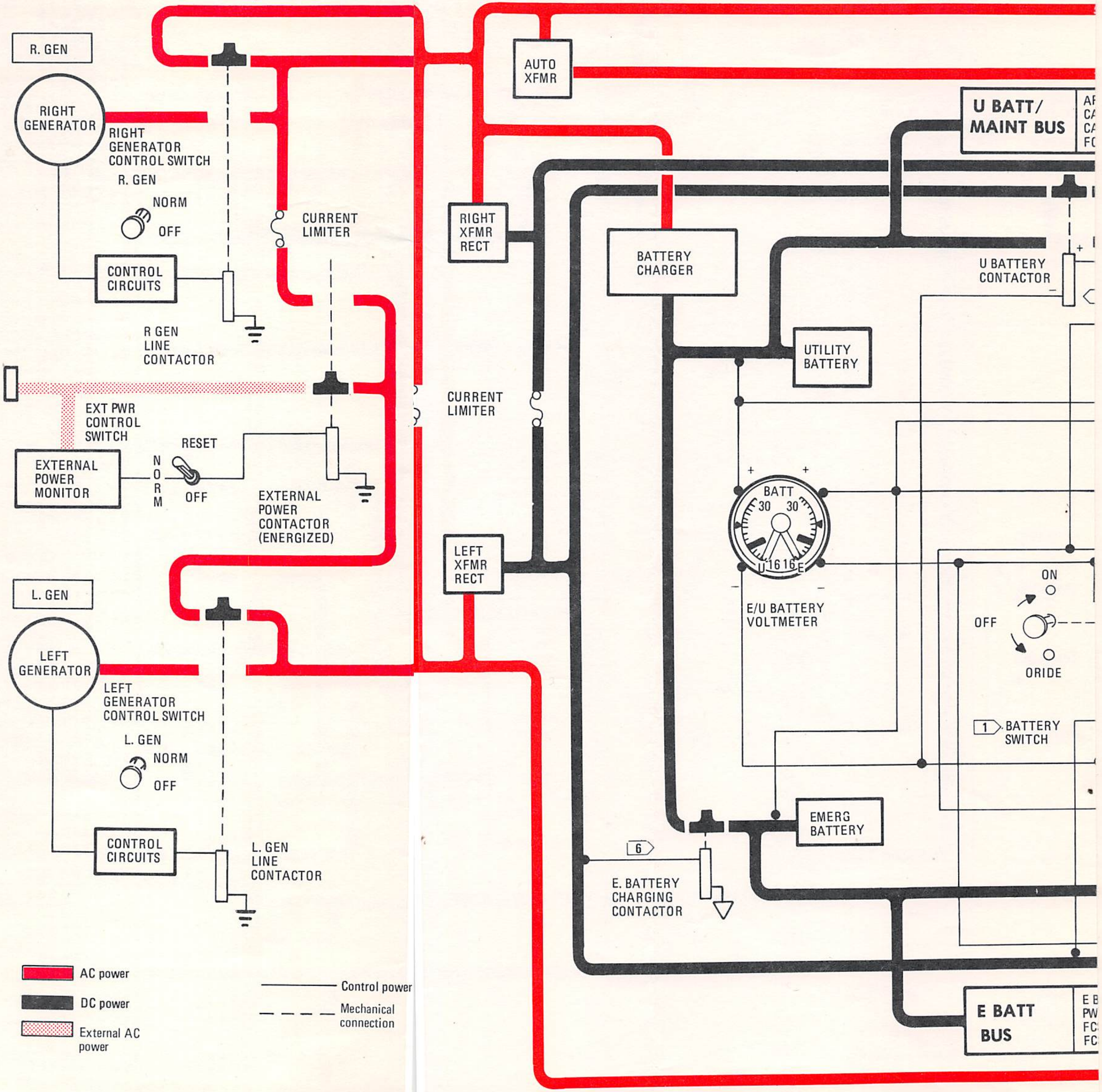
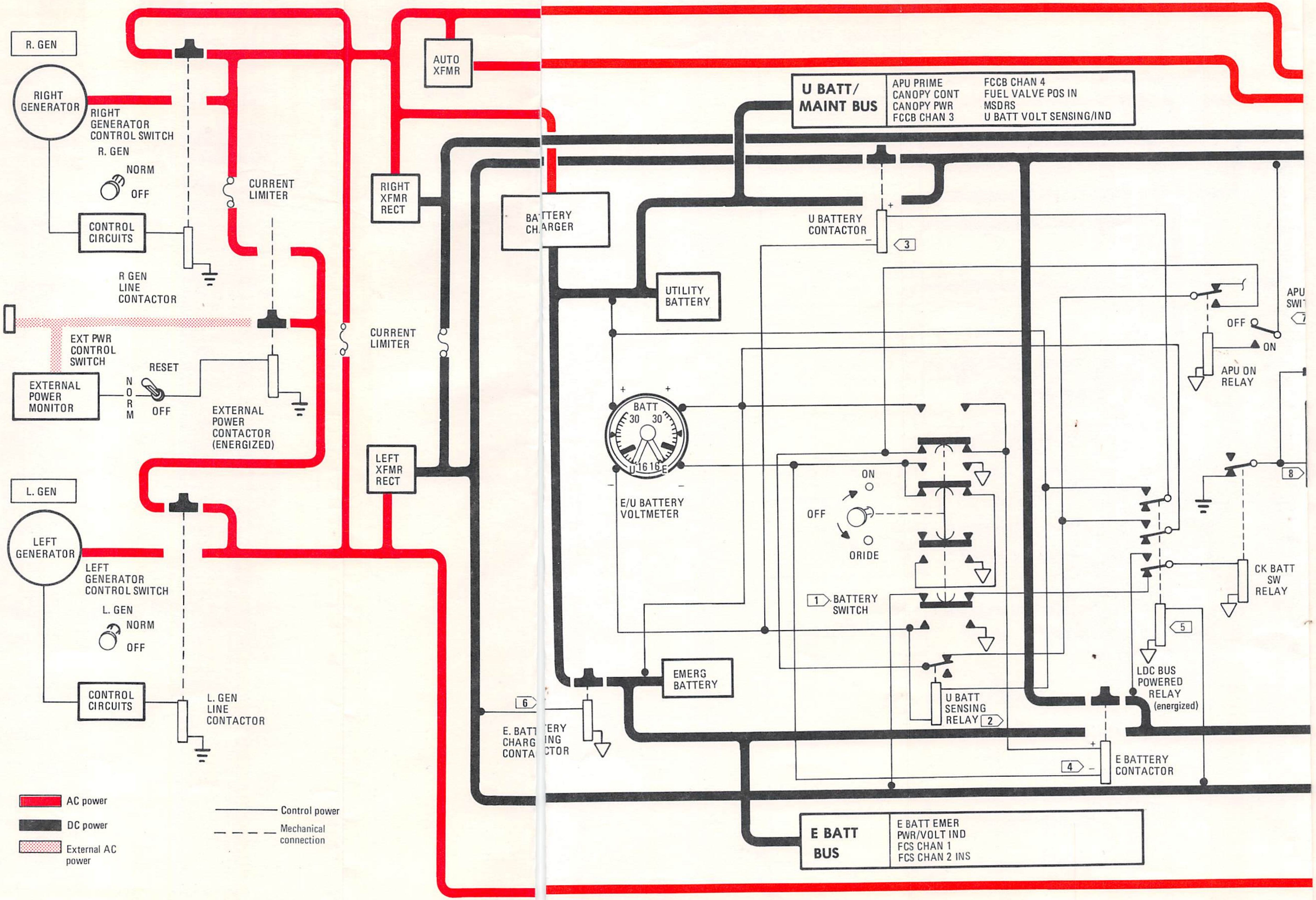
R

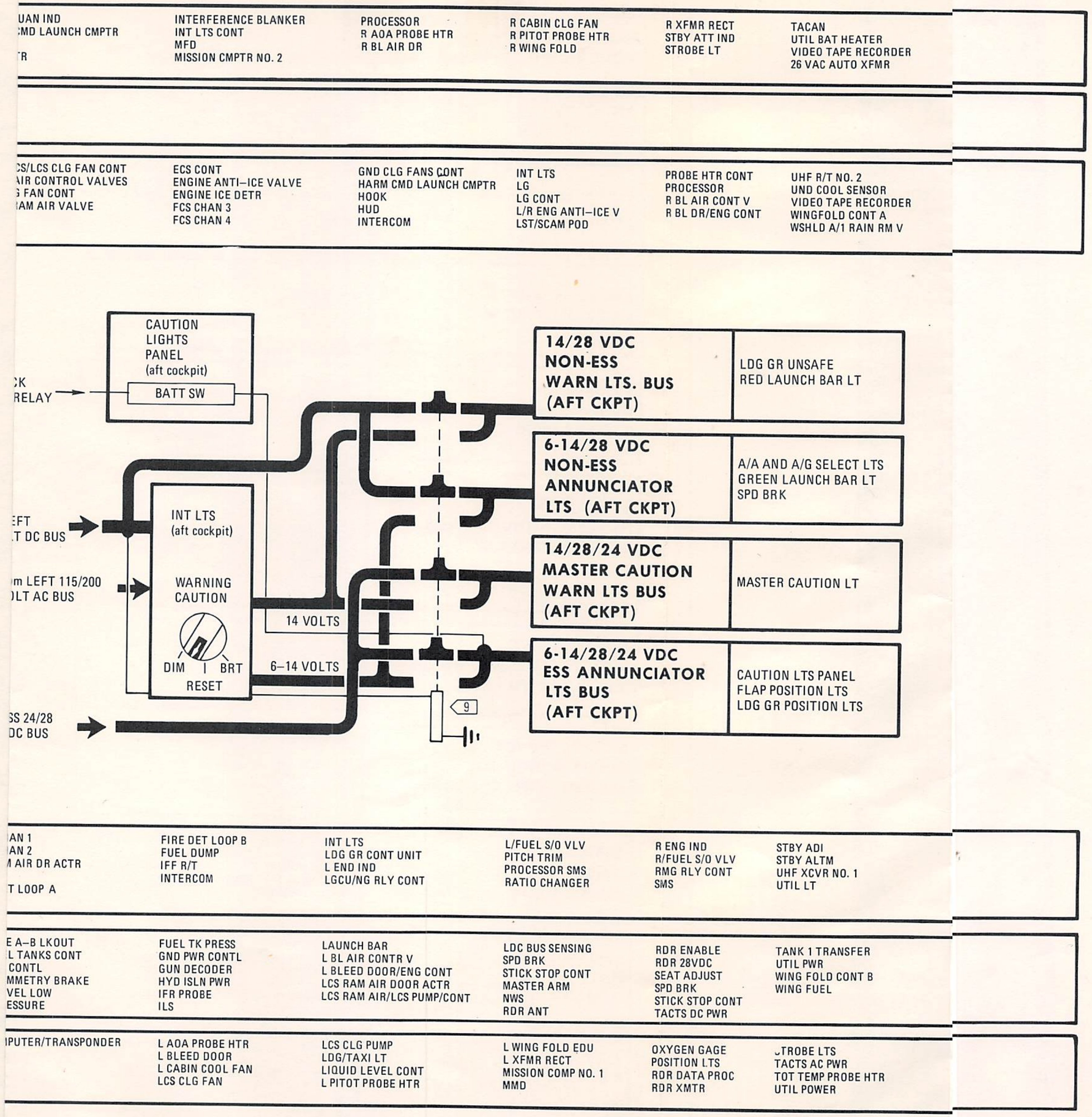
Figure FO-3. Electrical System (Sheet 1 of 2)


R. GEN
RIGHT GENERATOR
RIGHT GENERATOR CONTROL SWITCH
R. GEN
NORM
OFF
CONTROL CIRCUITS
R GEN LINE CONTACTOR
CURRENT LIMITER
EXT PWR CONTROL SWITCH
EXTERNAL POWER MONITOR
RESET
N O R M
OFF
EXTERNAL POWER CONTACTOR (ENERGIZED)
L. GEN
LEFT GENERATOR
LEFT GENERATOR CONTROL SWITCH
L. GEN
NORM
OFF
CONTROL CIRCUITS
L. GEN LINE CONTACTOR
AUTO XFMR
RIGHT XFMR RECT
CURRENT LIMITER
LEFT XFMR RECT
BATTERY CHARGER
U BATT/ MAINT BUS
U BATTERY CONTACTOR
UTILITY BATTERY
BATT
30
30
16
16
U
E
E/U BATTERY VOLTMETER
ON
OFF
ORIDE
1 BATTERY SWITCH
EMERG BATTERY
6
E. BATTERY CHARGING CONTACTOR
E BATT BUS
🟥 AC power
⬛ DC power
▨ External AC power
Control power
Mechanical connection


R. GEN
RIGHT GENERATOR
RIGHT GENERATOR CONTROL SWITCH
R. GEN
NORM
OFF
CONTROL CIRCUITS
R GEN LINE CONTACTOR
CURRENT LIMITER
EXT PWR CONTROL SWITCH
RESET
EXTERNAL POWER MONITOR
N O R M
OFF
EXTERNAL POWER CONTACTOR (ENERGIZED)
CURRENT LIMITER
AUTO XFMR
RIGHT XFMR RECT
LEFT XFMR RECT
L. GEN
LEFT GENERATOR
LEFT GENERATOR CONTROL SWITCH
L. GEN
NORM
OFF
CONTROL CIRCUITS
L. GEN LINE CONTACTOR
AC power
DC power
External AC power
Control power
Mechanical connection
BA TTERY CH ARGER
U BATT/ MAINT BUS
APU PRIME
CANOPY CONT
CANOPY PWR
FCCB CHAN 3
FCCB CHAN 4
FUEL VALVE POS IN
MSDRS
U BATT VOLT SENSING/IND
U BATTERY CONTACTOR
+
–
3
UTILITY BATTERY
APU SWI
7
OFF
ON
APU ON RELAY
+
+
BATT
30
30
U
16
16
E
–
–
E/U BATTERY VOLTMETER
ON
OFF
ORIDE
1
BATTERY SWITCH
8
CK BATT SW RELAY
5
LDC BUS POWERED RELAY (energized)
EMERG BATTERY
U BATT SENSING RELAY
2
6
E. BATT ERY CHARG ING CONTA CTOR
+
–
4
E BATTERY CONTACTOR
E BATT BUS
E BATT EMER PWR/VOLT IND
FCS CHAN 1
FCS CHAN 2 INS

Electrical System

EXTERNAL POWER APPLIED AIRPLANES 161702 AND UP



NOTES

Nomenclature callouts on the individual buses are circuit breaker nomenclatures. These nomenclature do not necessarily identify each system powered by the circuit breakers. In exception, the callouts on the lights buses are the lights powered by each bus. Reference to FWD CKPT refers to both F/A–18A and TF/A–18A aircraft. AFT CKPT refers only to TF/A–18A aircraft.

1 Battery switch shown in OFF position. Both battery contractors (U and E) and voltmeters are inoperative. Illumination of the BATT SW caution light indicates that there is ac power on the aircraft (LDC bus powered relay energized) with the switch in OFF. With battery switch in ON the U battery contractor energizes, provided power is off aircraft (LDC bus powered relay de–energized), and both voltmeters (U and E) indicate voltage of their respective batteries. Whenever battery switch is in ORIDE the E battery contractor energizes, and only E voltmeter is operative.

2 With battery switch in ON, U BATT sensing relay energizes and monitors U battery voltage. When U battery voltage drops to 20.5 volts or below, the U BATT sensing relay de-energizes causing the E battery contactor to energize, provided LDC bus powered relay is de-energized. An anti-cycling circuit (not shown) locks in the E battery contactor, preventing the U battery from re-energizing the essential dc buses. The anti-cycling circuit operates only if the low voltage duration on the U battery is greater than 0.5 second.

3 U battery contactor energizes with battery switch in ON, providing the LDC bus powered relay is de–energized.

4 E battery contactor energizes with battery switch in ON, provided LDC bus powered relay is de–energized and voltage on U battery is 20.5 volts or below. With battery switch in ORIDE, contactor energizes regardless of LDC bus powered relay status. The E battery contractor will also energize with the APU switch ON, provided the battery switch is ON and the LDC powered relay is de–energized.

5 LDC bus powered relay energizes only when power is on the left 28 volt dc bus (can occur only with external or engine generator ac power on aircraft).

6 E battery charging contactor energizes to charge the E battery from the battery charger, provided the left 28 volt dc bus is energized. When left 28 volt bus is de–energized, E battery charging contactor de–energizes to allow battery charger to supply charge only to the U battery.

7 APU ON relay energizes to cause the E battery contactor to energize, provided the battery switch is ON and the LDC bus powered relay is de–energized.

8 BATT SW caution light comes on with battery switch ON and no ac power on the aircraft (examples: double generator failure or, on the ground, switch ON for engine start without external power or switch left ON inadvertently after engine shutdown). BATT SW caution light also comes on with battery switch OFF, providing ac power is on the aircraft (example: switch placed to OFF during normal flight). BATT SW caution light comes on whenever battery switch is in ORIDE, regardless of LDC bus power relay status (example: battery switch placed inadvertently to ORIDE during normal flight). With LDC bus power relay de–energized (double generator failure, double transformer–rectifier failure, etc.), illumination of the BATT SW caution light indicates that the essential dc buses are being powered by either the utility or emergency battery. A BATT SW display on the DDI's operate in parallel with BATT SW caution light, however, the DDI display is inoperative with loss of ac power.

9 Dimming relay shown in the de–energized, or undimmed state. To energize, the warning/caution lights control knob must be placed to the reset position, providing the right 28 volt DC bus (left 28 volt DC bus for AFT CKPT) is energized, the instrument lights panel knob is not in the OFF position, and the flood lights knob is not in the BRT position.

10 F/A–18A

11 TF/A–18A

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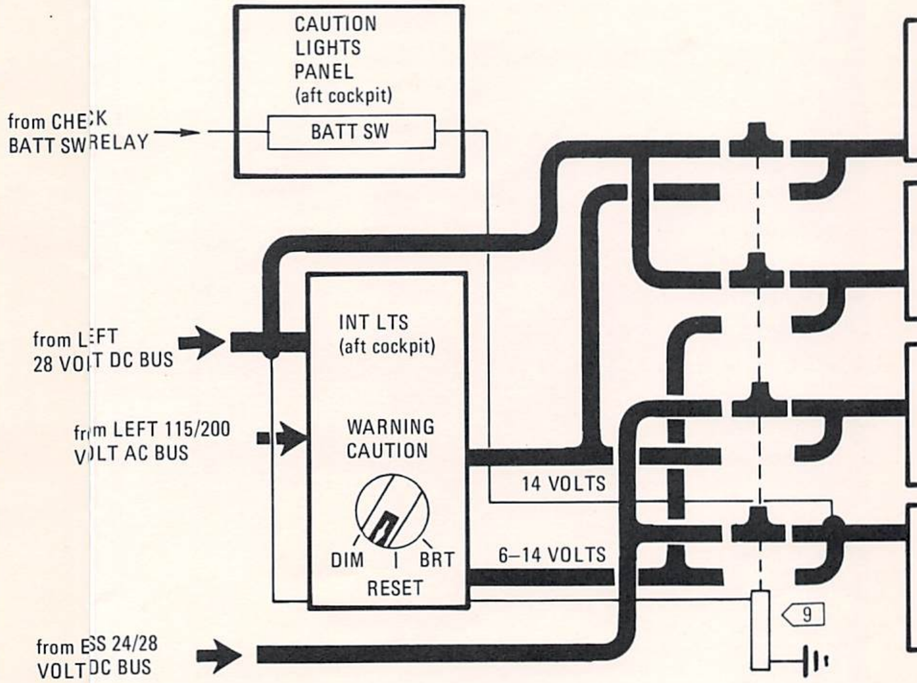
Figure FO-3. Electrical System (Sheet 2)

RIGHT 115/200 VOLT AC BUS	ADC AMAC APRCH LT ARM STA 5 THRU 9 AVIONICS CLG FAN BATT CHANGING/TRU CSC ECS CONT ELEC ALT FUEL QUAN IND HARM CMD LAUNCH CMPTR HUD ICE DETR INTERFERENCE BLANKER INT LTS CONT MFD MISSION CMPTR NO. 2 PROCESSOR R AOA PROBE HTR R BL AIR DR R CABIN CLG FAN R PITOT PROBE HTR R WING FOLD R XFMR RECT STBY ATT IND STROBE LT TACAN UTIL BAT HEATER VIDEO TAPE RECORDER 26 VAC AUTO XFMR
RIGHT 26 VOLT AC BUS	ADF HYD SYS NO. 1 HYD SYS NO. 2 INS
RIGHT 28 VOLT DC BUS	ADF AMAC AN ALE 39 CONT AN ALE 39 PWR ANT SEL APC APRCH LT CONT ARM STA 5 THRU 9 ARM STA 7 AERO 5 ARM STA 8 AERO 5 AUG RCVR – BEACON AVIONICS/LCS CLG FAN CONT BLEED AIR CONTROL VALVES CAB CLG FAN CONT CABIN RAM AIR VALVE CSC ECS CONT ENGINE ANTI–ICE VALVE ENGINE ICE DETR FCS CHAN 3 FCS CHAN 4 GND CLG FANS CONT HARM CMD LAUNCH CMPTR HOOK HUD INTERCOM INT LTS LG LG CONT L/R ENG ANTI–ICE V LST/SCAM POD PROBE HTR CONT PROCESSOR R BL AIR CONT V R BL DR/ENG CONT UHF R/T NO. 2 UND COOL SENSOR VIDEO TAPE RECORDER WINGFOLD CONT A WSHLD A/1 RAIN RM V
ENGINE START 24/28 VOLT DC BUS	ENGINE START APU
14/28 VDC NON-ESS WARN LTS BUS (FWD CKPT)	HOOK LT ELECTRONIC ALT LOW ALT LT RED LAUNCH BAR LT ◁11
6-14/28 VDC NON-ESS ANNUNCIATOR LTS BUS (FWD CKPT)	A/A AND A/G SELECT LTS AAA LT AI LT CW LT GREEN LAUNCH BAR LT LOCK AND SHOOT LTS RCDR ON LT SAM LT SPD BRK STATION SELECT LTS
14/28/24 VDC MASTER CAUTION/WARN LTS BUS (FWD CKPT)	LDG GR HDL LT MASTER CAUTION LT RED LAUNCH BAR LT ◁10 SPIN RECOVERY LIGHT
6-14/28/24 VDC ESS ANNUNCIATOR LTS BUS (FWD CKPT)	APU READY LT CAUTION LTS PANEL FLAP POSITION LTS LDG GR POSITION LTS READY/DISCH LTS
ESSENTIAL 24/28 VOLT DC BUS	ARM STA 2 THRU 6 ASYM BK FCCA BL AIR LEAK DET LOOP A BL AIR LEAK DET LOOP B CAB AIR DUMP VLV CHECK BAT RELAY SW EMER IFR CROSSFEED FUEL VLV ENG MON FCES CHAN 1 FCES CHAN 2 FCS RAM AIR DR ACTR FEXT FIRE DET LOOP A FIRE DET LOOP B FUEL DUMP IFF R/T INTERCOM INT LTS LDG GR CONT UNIT L END IND LGCU/NG RLY CONT L/FUEL S/O VLV PITCH TRIM PROCESSOR SMS RATIO CHANGER R ENG IND R/FUEL S/O VLV RMG RLY CONT SMS STBY ADI STBY ALTM UHF XCVR NO. 1 UTIL LT
LEFT 28 VOLT DC BUS	AFT SEAT ADJUST ◁11 ALR–67 IND CONT/FLTR ANTI SKID ARM STA 1 THRU 4 ARM STA 2 THRU 5 ARM STA 3 THRU 5 ASY BK FCC–B BLD AIR DOOR CONT DATA LINK ECM CLG VALVE EJCTR VALVES ENG IDLE A–B LKOUT EXT FUEL TANKS CONT EXT LTS CONTL FCC ASYMMETRY BRAKE FUEL LEVEL LOW FUEL PRESSURE FUEL TK PRESS GND PWR CONTL GUN DECODER HYD ISLN PWR IFR PROBE ILS LAUNCH BAR L BL AIR CONTR V L BLEED DOOR/ENG CONT LCS RAM AIR DOOR ACTR LCS RAM AIR/LCS PUMP/CONT LDC BUS SENSING SPD BRK STICK STOP CONT MASTER ARM NWS RDR ANT RDR ENABLE RDR 28VDC SEAT ADJUST SPD BRK STICK STOP CONT TACTS DC PWR TANK 1 TRANSFER UTIL PWR WING FOLD CONT B WING FUEL
LEFT 115/200 VOLT AC BUS	ALQ–126 ALR–67 ARM STA 1 THRU 4 AWW–4 EHSI/HSO (RPTR DISPLAY) EMER BAT HTR FORMATION LTS GUN DECODER IFF COMPUTER/TRANSPONDER IFR LTS ILS INS L AOA PROBE HTR L BLEED DOOR L CABIN COOL FAN LCS CLG FAN LCS CLG PUMP LDG/TAXI LT LIQUID LEVEL CONT L PITOT PROBE HTR L WING FOLD EDU L XFMR RECT MISSION COMP NO. 1 MMD OXYGEN GAGE POSITION LTS RDR DATA PROC RDR XMTR STROBE LTS TACTS AC PWR TOT TEMP PROBE HTR UTIL POWER



14/28 VDC NON-ESS WARN LTS. BUS (AFT CKPT)	LDG GR UNSAFE RED LAUNCH BAR LT
6-14/28 VDC NON-ESS ANNUNCIATOR LTS (AFT CKPT)	A/A AND A/G SELECT LTS GREEN LAUNCH BAR LT SPD BRK
14/28/24 VDC MASTER CAUTION WARN LTS BUS (AFT CKPT)	MASTER CAUTION LT
6-14/28/24 VDC ESS ANNUNCIATOR LTS BUS (AFT CKPT)	CAUTION LTS PANEL FLAP POSITION LTS LDG GR POSITION LTS

Ejection Seat

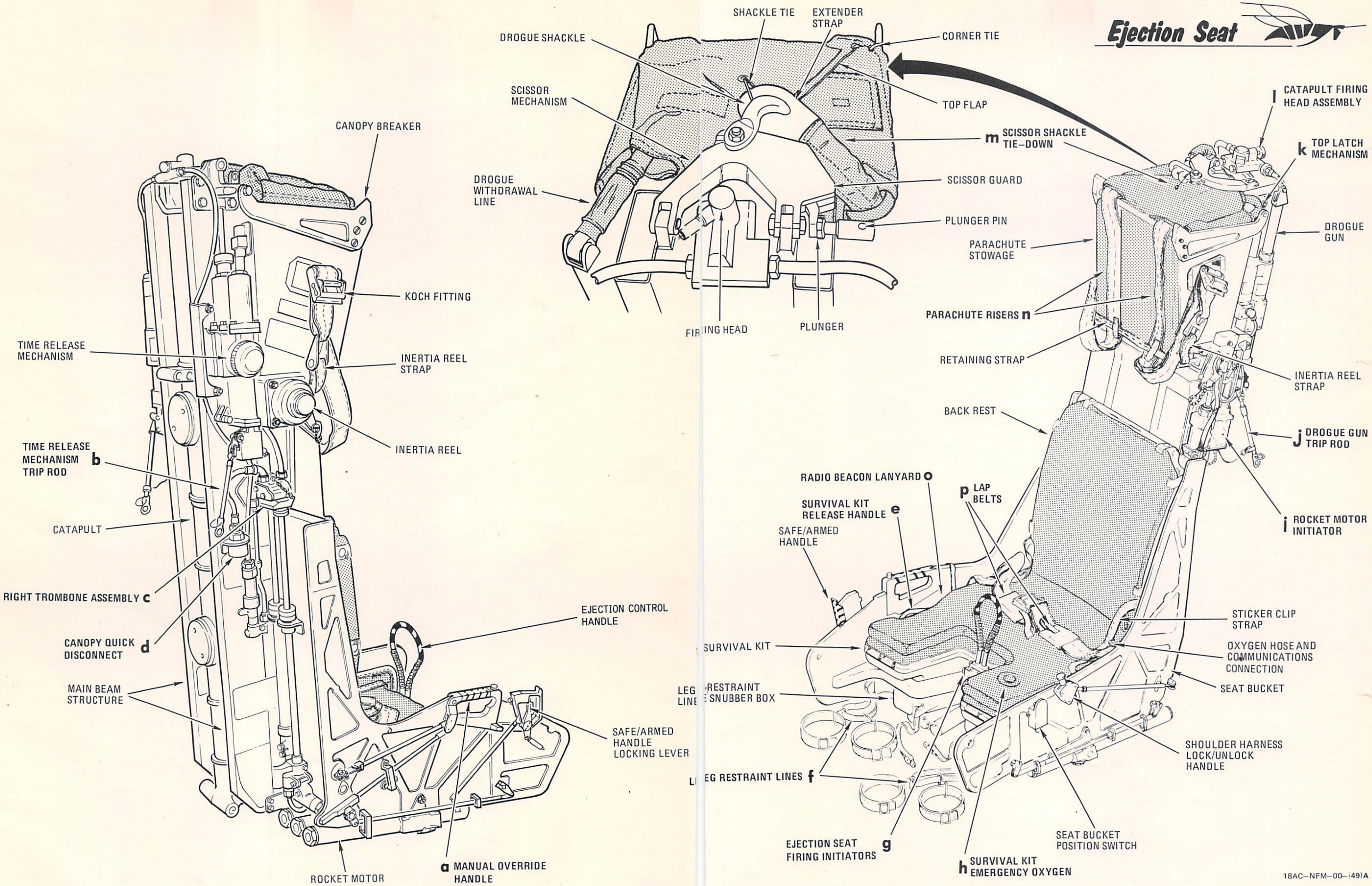


Figure FO-4. Ejection Seat

Flight Controls

5.3.1 PROM

NOTES

1. IN THE MECHANICAL MODE, THE RATIO CHANGER ACTUATOR AUTOMATICALLY INCREASES THE PITCH RATIO WHEN THE FLAPS ARE FULL DOWN.
2. AFTER APPROXIMATELY 7 SECONDS, THE CIRCUIT OPENS AND THE UTILITY BATTERY NO LONGER POWERS FLIGHT CONTROL COMPUTER B.

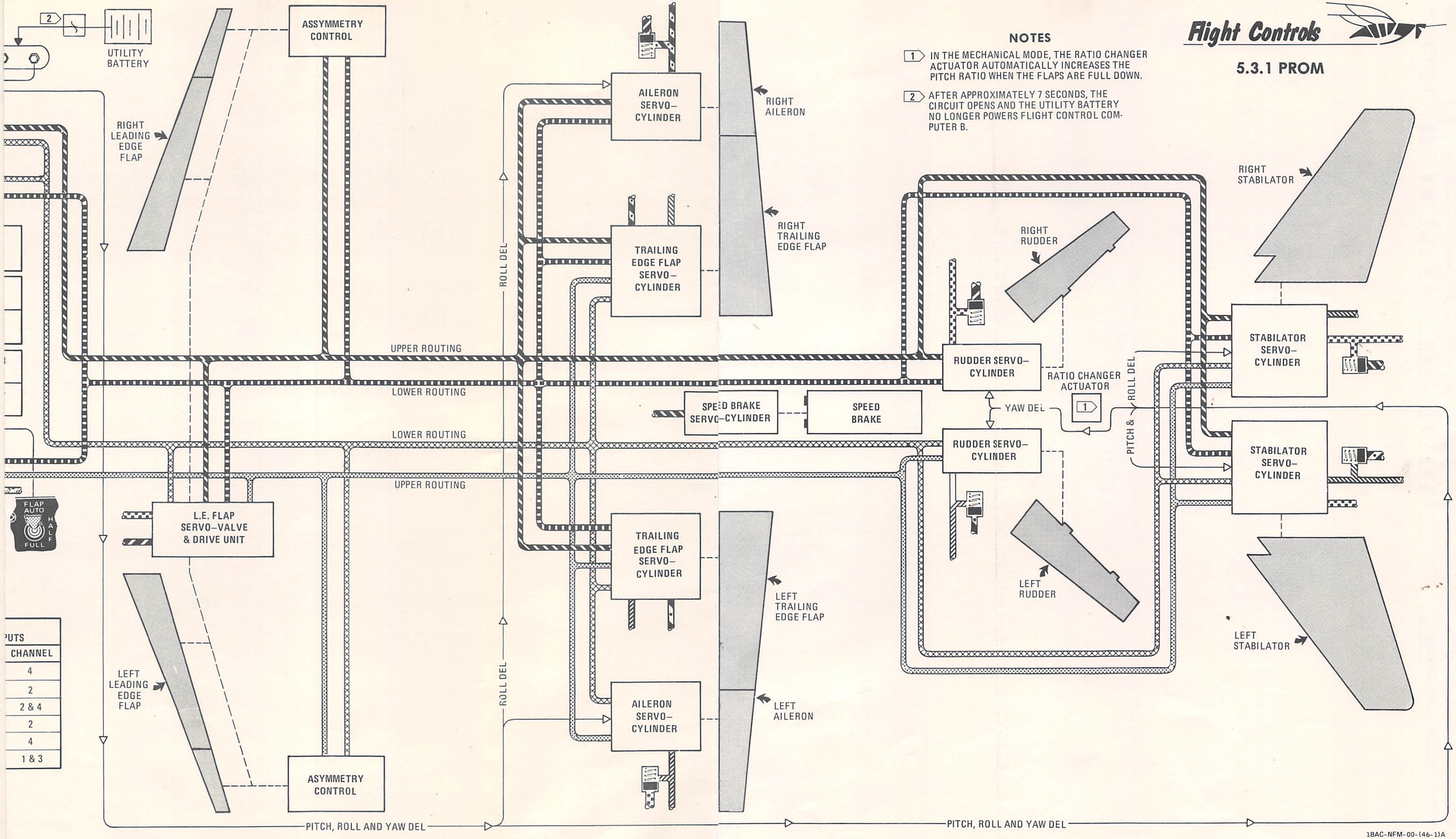
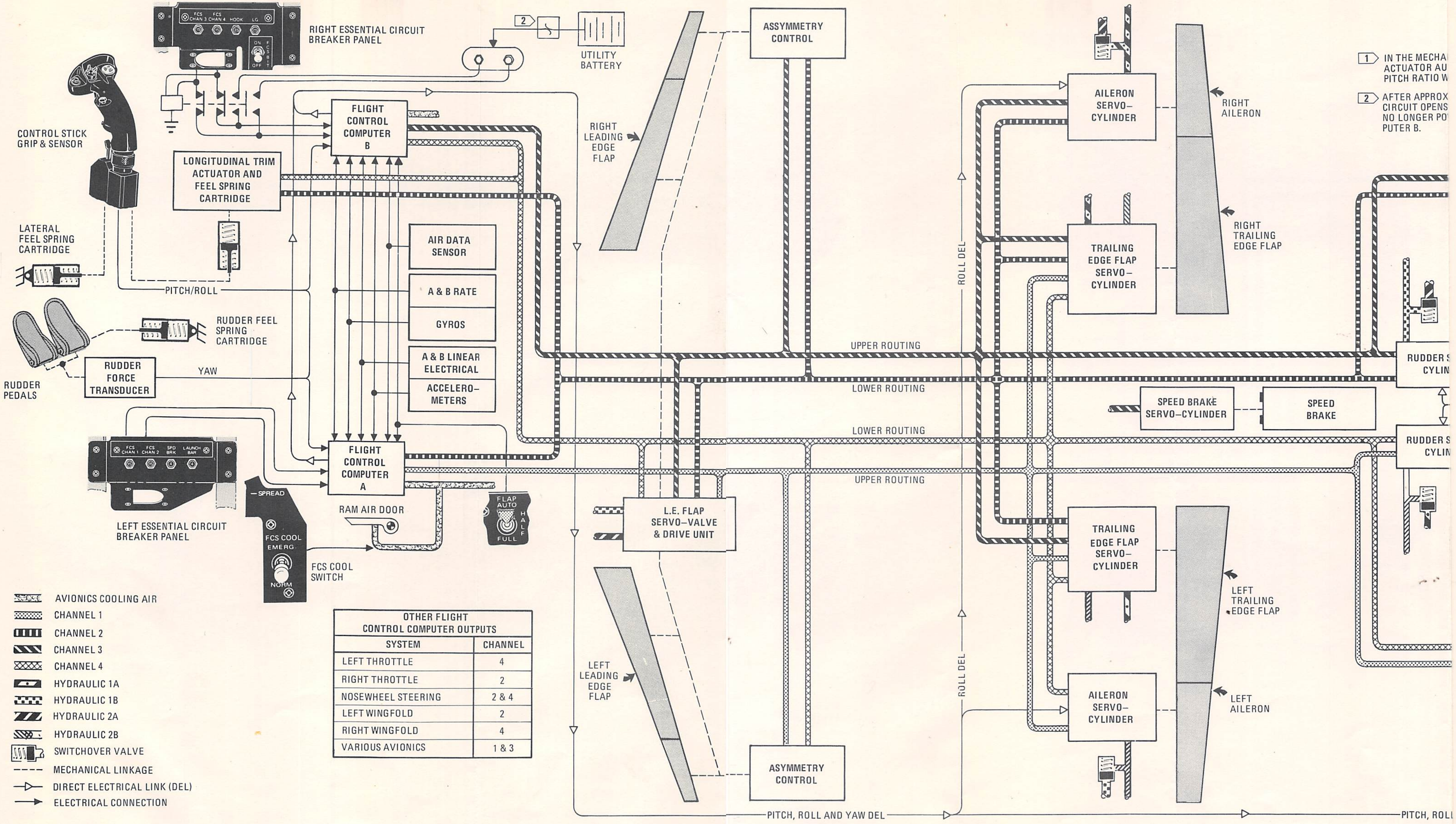


Figure FO-5. Flight Controls (Sheet 1 of 2)



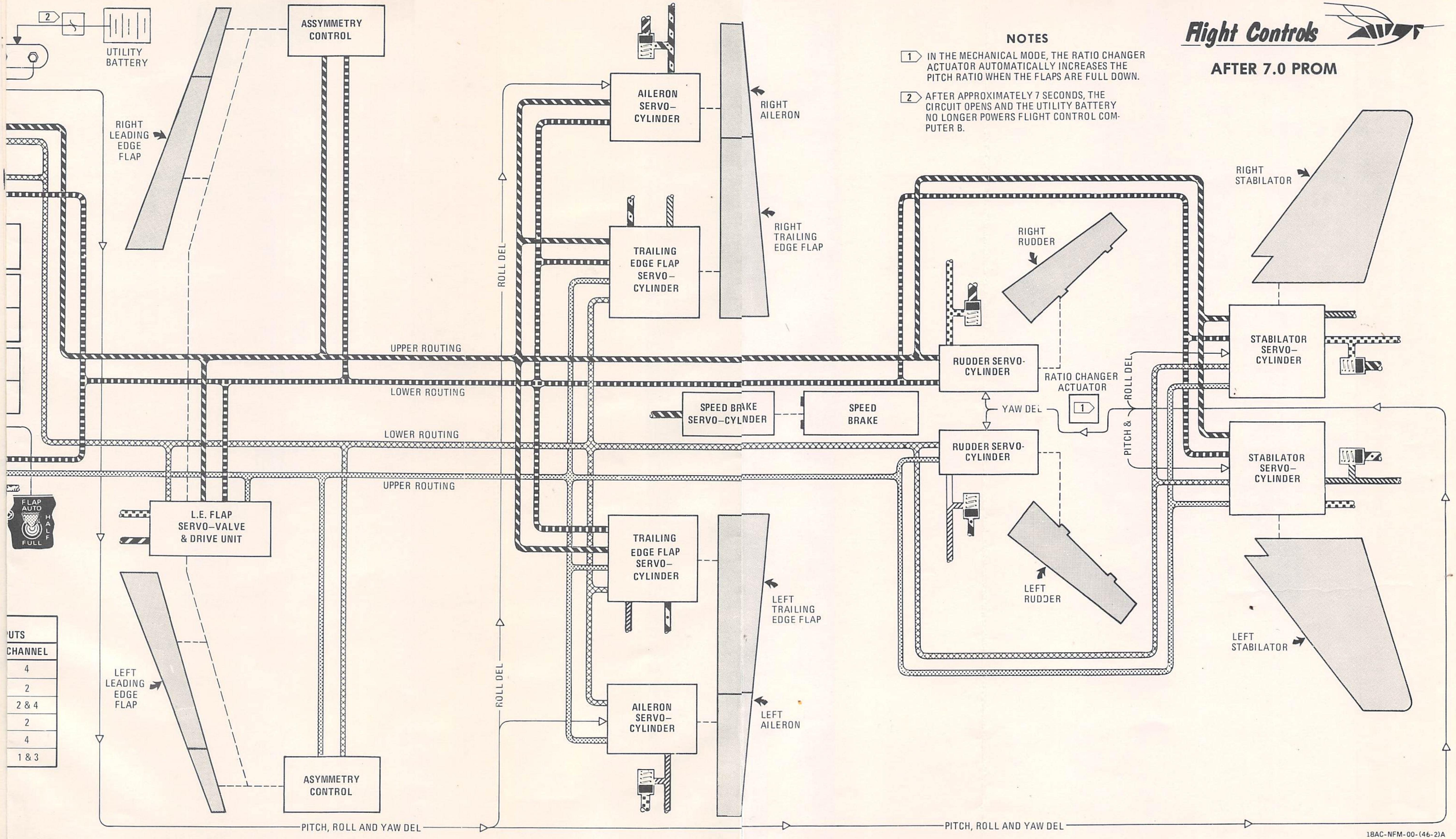
OTHER FLIGHT CONTROL COMPUTER OUTPUTS	
SYSTEM	CHANNEL
LEFT THROTTLE	4
RIGHT THROTTLE	2
NOSEWHEEL STEERING	2 & 4
LEFT WINGFOLD	2
RIGHT WINGFOLD	4
VARIOUS AVIONICS	1 & 3

1 IN THE MECHA
ACTUATOR AU
PITCH RATIO W

2 AFTER APPROX
CIRCUIT OPENS
NO LONGER PO
PUTER B.

Flight Controls

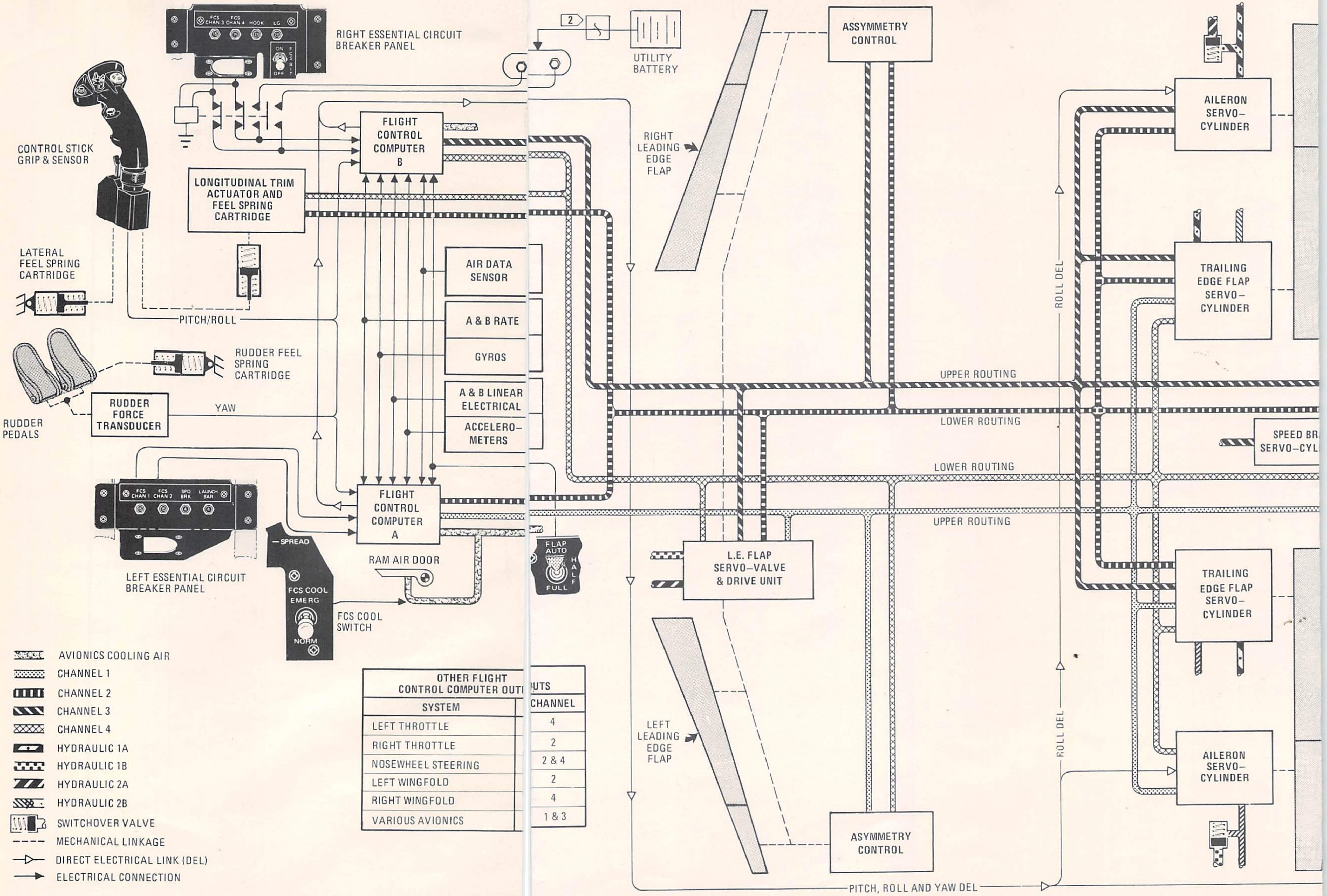
AFTER 7.0 PROM



NOTES

1. IN THE MECHANICAL MODE, THE RATIO CHANGER ACTUATOR AUTOMATICALLY INCREASES THE PITCH RATIO WHEN THE FLAPS ARE FULL DOWN.
2. AFTER APPROXIMATELY 7 SECONDS, THE CIRCUIT OPENS AND THE UTILITY BATTERY NO LONGER POWERS FLIGHT CONTROL COMPUTER B.

Figure FO-5. Flight Controls (Sheet 2)



OTHER FLIGHT CONTROL COMPUTER OUTPUTS

SYSTEM	CHANNEL
LEFT THROTTLE	4
RIGHT THROTTLE	2
NOSEWHEEL STEERING	2 & 4
LEFT WINGFOLD	2
RIGHT WINGFOLD	4
VARIOUS AVIONICS	1 & 3

Fuel System

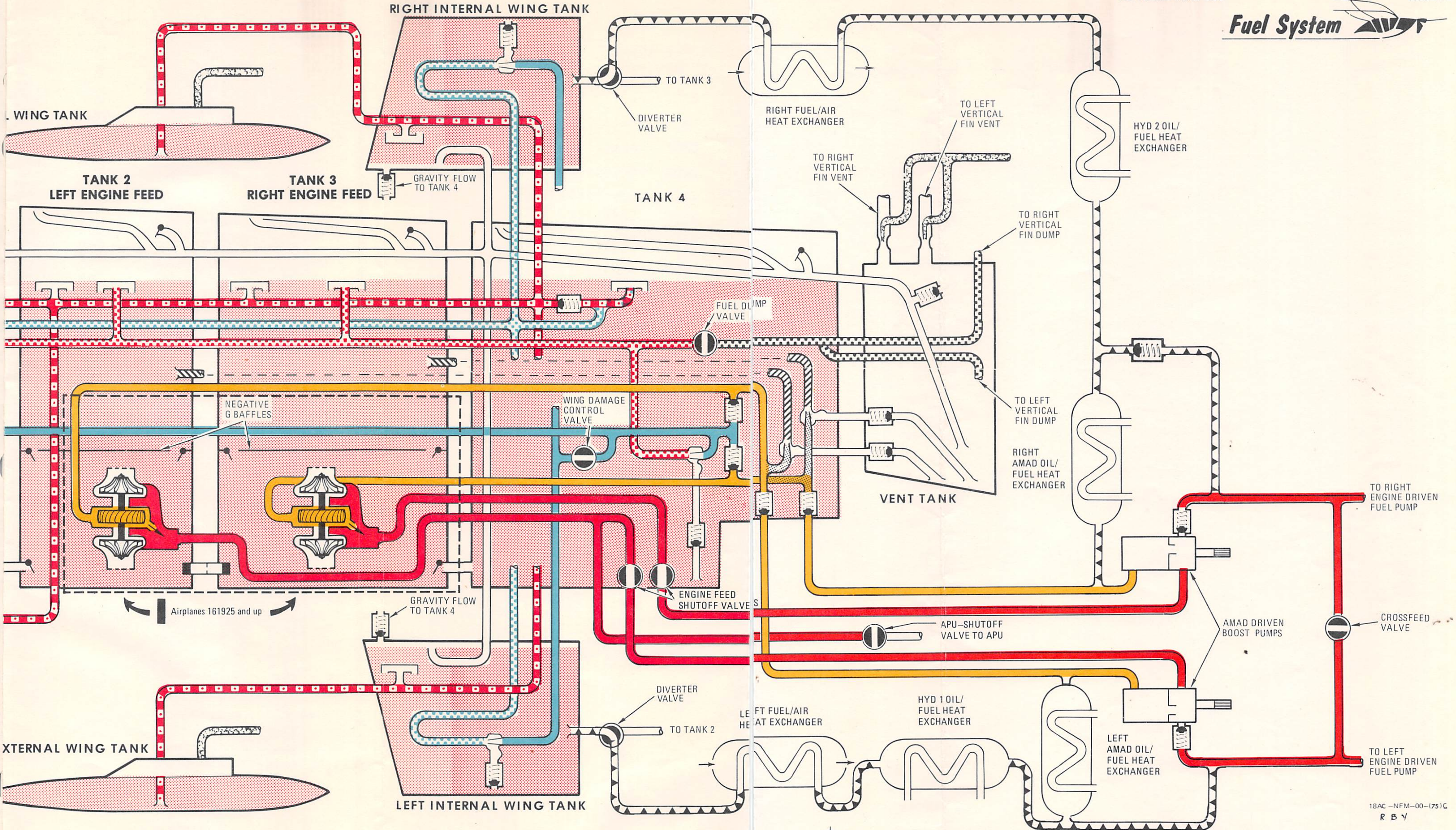
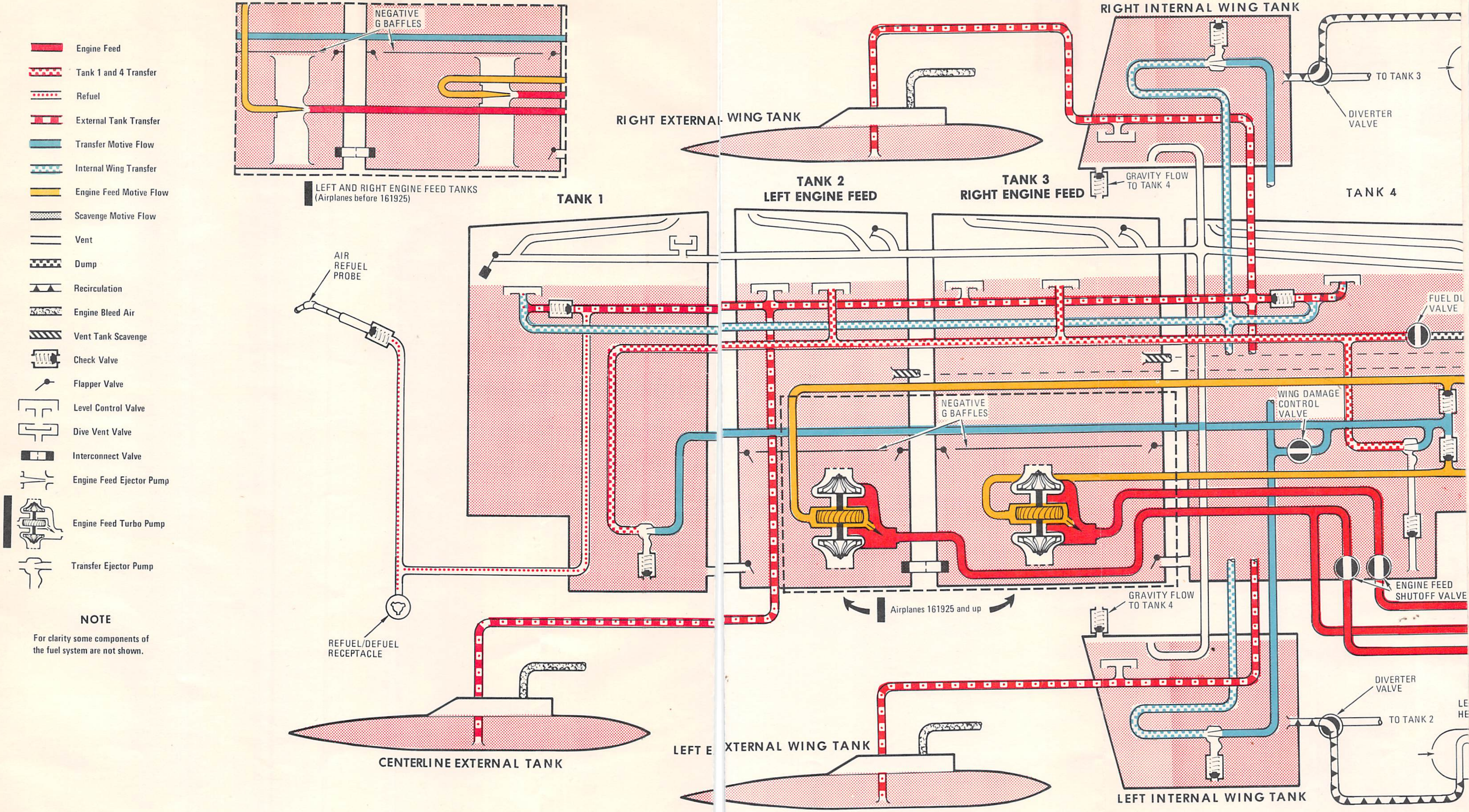


Figure FO-6. Fuel System

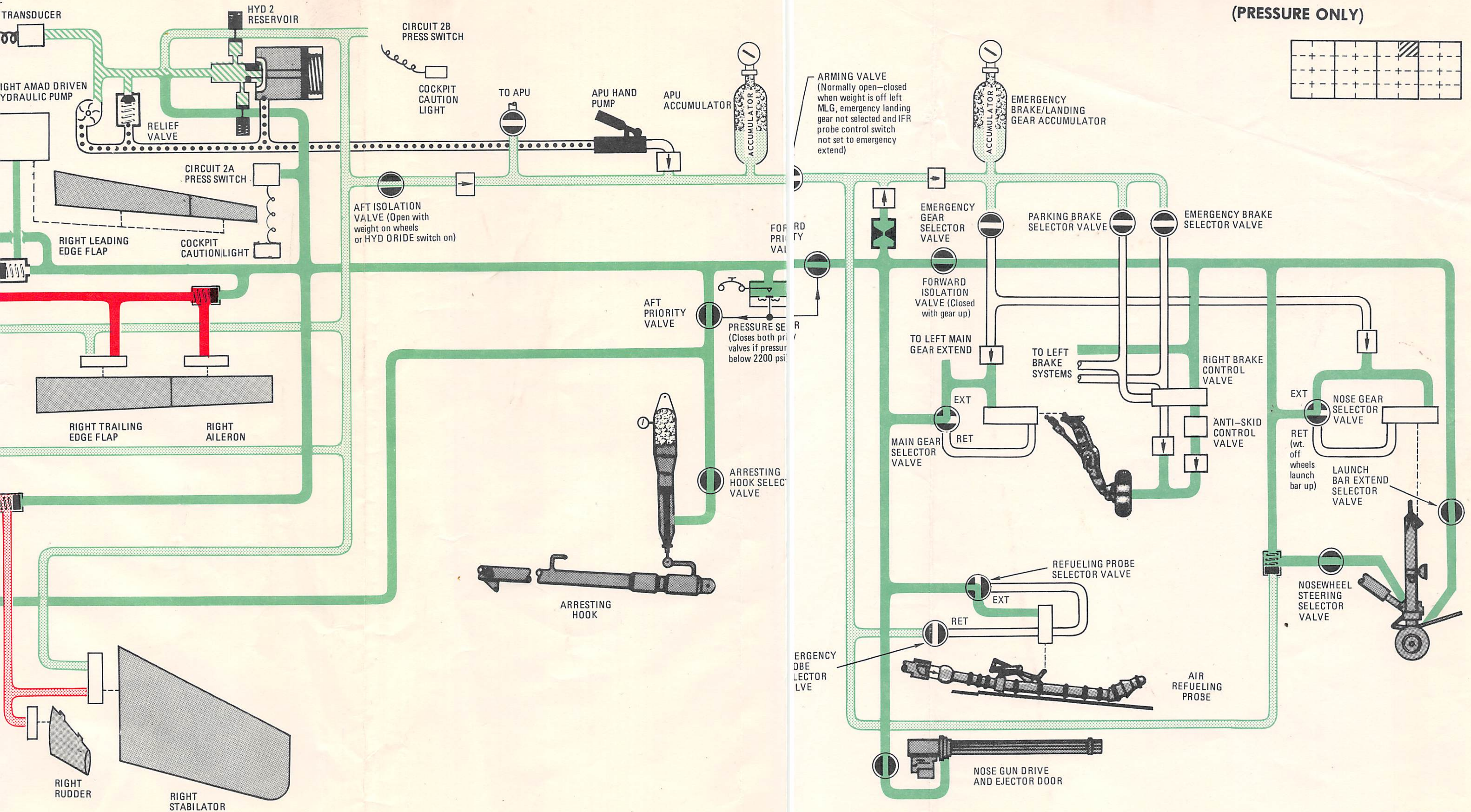


NOTE

For clarity some components of the fuel system are not shown.

Hydraulics Systems

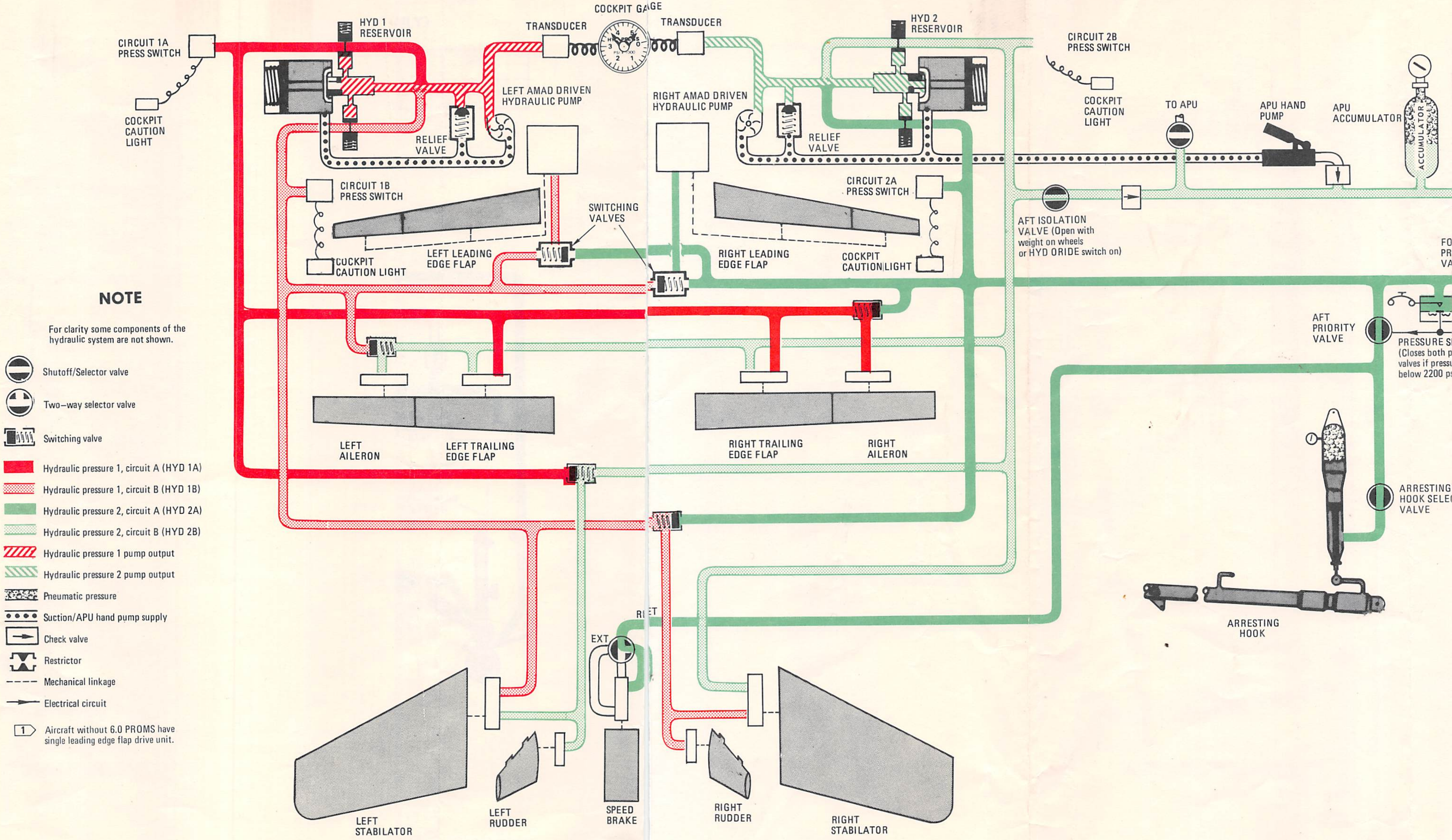
(PRESSURE ONLY)


TRANSDUCER
HYD 2 RESERVOIR
CIRCUIT 2B PRESS SWITCH
IGHT AMAD DRIVEN YDRAULIC PUMP
RELIEF VALVE
COCKPIT CAUTION LIGHT
TO APU
APU HAND PUMP
APU ACCUMULATOR
ACCUMULATOR
ARMING VALVE (Normally open—closed when weight is off left MLG, emergency landing gear not selected and IFR probe control switch not set to emergency extend)
EMERGENCY BRAKE/LANDING GEAR ACCUMULATOR
ACCUMULATOR
CIRCUIT 2A PRESS SWITCH
RIGHT LEADING EDGE FLAP
COCKPIT CAUTION LIGHT
AFT ISOLATION VALVE (Open with weight on wheels or HYD ORIDE switch on)
FOR RD PRI TY VAL
EMERGENCY GEAR SELECTOR VALVE
PARKING BRAKE SELECTOR VALVE
EMERGENCY BRAKE SELECTOR VALVE
FORWARD ISOLATION VALVE (Closed with gear up)
AFT PRIORITY VALVE
PRESSURE SE R (Closes both pr valves if pressur below 2200 psi
TO LEFT MAIN GEAR EXTEND
TO LEFT BRAKE SYSTEMS
RIGHT BRAKE CONTROL VALVE
EXT
NOSE GEAR SELECTOR VALVE
RET (wt. off wheels launch bar up)
EXT
RET
MAIN GEAR SELECTOR VALVE
ANTI-SKID CONTROL VALVE
RIGHT TRAILING EDGE FLAP
RIGHT AILERON
ARRESTING HOOK SELEC VALVE
LAUNCH BAR EXTEND SELECTOR VALVE
ARRESTING HOOK
REFUELING PROBE SELECTOR VALVE
EXT
RET
NOSEWHEEL STEERING SELECTOR VALVE
ERGENCY OBE LECTOR LVE
AIR REFUELING PROBE
RIGHT RUDDER
RIGHT STABILATOR
NOSE GUN DRIVE AND EJECTOR DOOR

18AC-NFM-00-(47)D

RG

Figure FO-7. Hydraulic Systems



NOTE

For clarity some components of the hydraulic system are not shown.

⊖ Shutoff/Selector valve

⊕ Two–way selector valve

▥ Switching valve

🟥 Hydraulic pressure 1, circuit A (HYD 1A)

▨ Hydraulic pressure 1, circuit B (HYD 1B)

🟩 Hydraulic pressure 2, circuit A (HYD 2A)

▨ Hydraulic pressure 2, circuit B (HYD 2B)

▨ Hydraulic pressure 1 pump output

▨ Hydraulic pressure 2 pump output

▨ Pneumatic pressure

• • • • Suction/APU hand pump supply

→ Check valve

⧗ Restrictor

– – – – Mechanical linkage

—→ Electrical circuit

1 Aircraft without 6.0 PROMS have single leading edge flap drive unit.

Environmental Control System

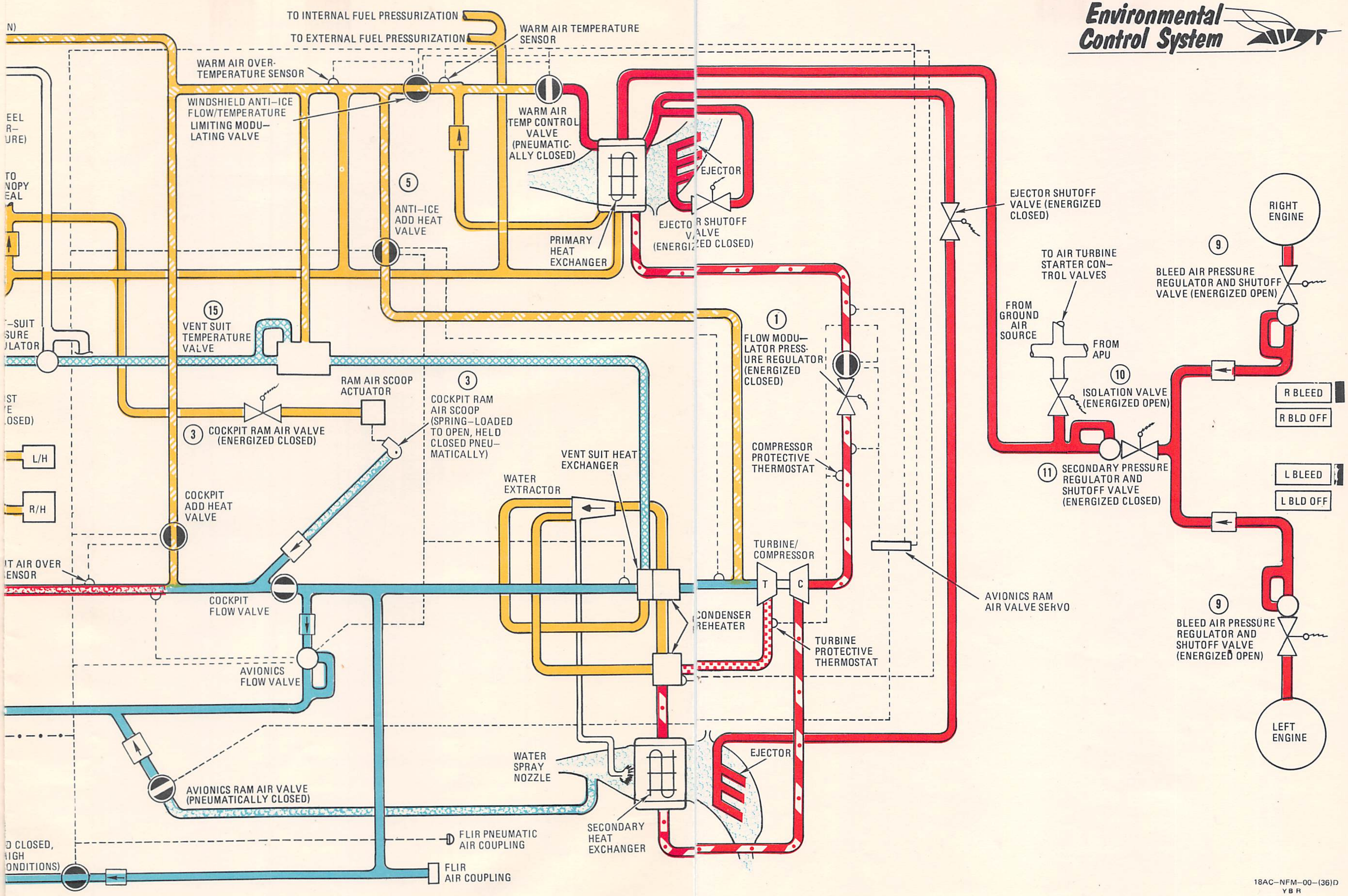
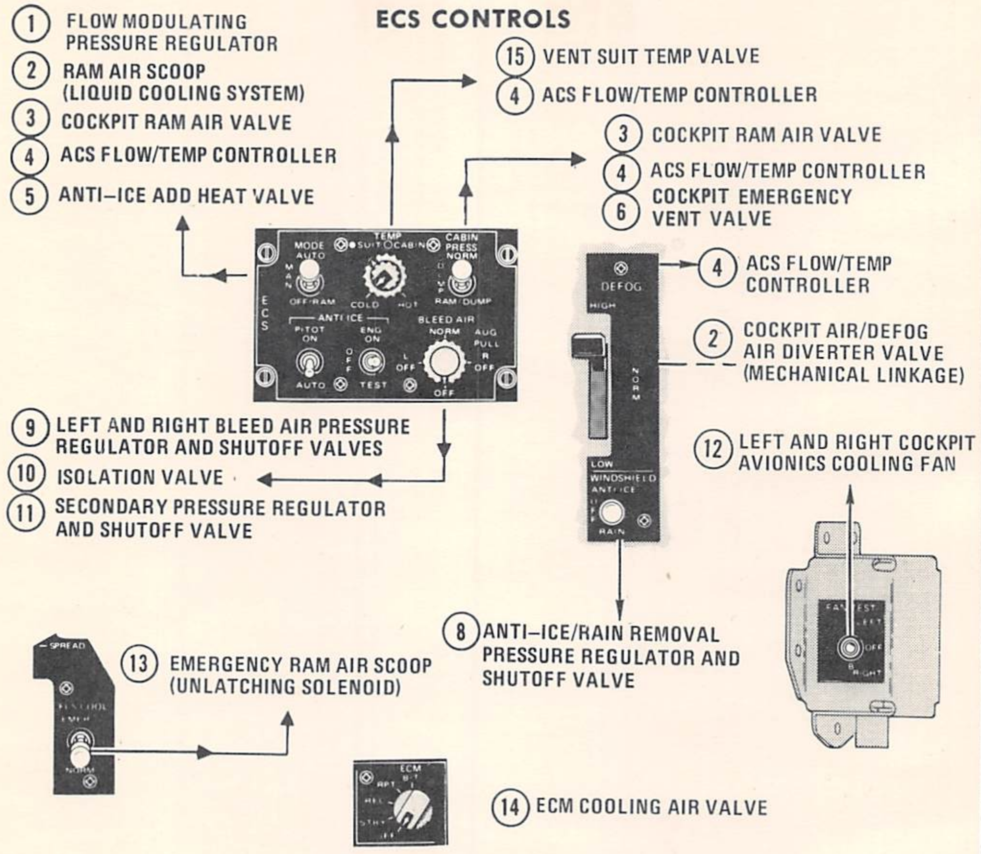

N)
TO INTERNAL FUEL PRESSURIZATION
TO EXTERNAL FUEL PRESSURIZATION
WARM AIR TEMPERATURE SENSOR
WARM AIR OVER-TEMPERATURE SENSOR
WINDSHIELD ANTI-ICE FLOW/TEMPERATURE LIMITING MODULATING VALVE
WARM AIR TEMP CONTROL VALVE (PNEUMATICALLY CLOSED)
EEL R- URE)
TO NOPY EAL
5
ANTI-ICE ADD HEAT VALVE
PRIMARY HEAT EXCHANGER
EJECTOR
EJECTOR SHUTOFF VALVE (ENERGIZED CLOSED)
EJECTOR SHUTOFF VALVE (ENERGIZED CLOSED)
RIGHT ENGINE
9
BLEED AIR PRESSURE REGULATOR AND SHUTOFF VALVE (ENERGIZED OPEN)
TO AIR TURBINE STARTER CONTROL VALVES
FROM GROUND AIR SOURCE
FROM APU
10
ISOLATION VALVE (ENERGIZED OPEN)
R BLEED
R BLD OFF
11
SECONDARY PRESSURE REGULATOR AND SHUTOFF VALVE (ENERGIZED CLOSED)
L BLEED
L BLD OFF
-SUIT SURE ULATOR
15
VENT SUIT TEMPERATURE VALVE
1
FLOW MODULATOR PRESSURE REGULATOR (ENERGIZED CLOSED)
IST E OSED)
RAM AIR SCOOP ACTUATOR
3
COCKPIT RAM AIR SCOOP (SPRING-LOADED TO OPEN, HELD CLOSED PNEUMATICALLY)
3
COCKPIT RAM AIR VALVE (ENERGIZED CLOSED)
COMPRESSOR PROTECTIVE THERMOSTAT
L/H
R/H
VENT SUIT HEAT EXCHANGER
WATER EXTRACTOR
COCKPIT ADD HEAT VALVE
T AIR OVER ENSOR
TURBINE/ COMPRESSOR
T
C
AVIONICS RAM AIR VALVE SERVO
COCKPIT FLOW VALVE
CONDENSER REHEATER
TURBINE PROTECTIVE THERMOSTAT
9
BLEED AIR PRESSURE REGULATOR AND SHUTOFF VALVE (ENERGIZED OPEN)
AVIONICS FLOW VALVE
LEFT ENGINE
WATER SPRAY NOZZLE
EJECTOR
AVIONICS RAM AIR VALVE (PNEUMATICALLY CLOSED)
SECONDARY HEAT EXCHANGER
D CLOSED, IGH ONDITIONS)
FLIR PNEUMATIC AIR COUPLING
FLIR AIR COUPLING
18AC-NFM-00-(36)D
Y B R

Figure FO-8. Environmental Control System

ECS CONTROLS


① FLOW MODULATING PRESSURE REGULATOR
② RAM AIR SCOOP (LIQUID COOLING SYSTEM)
③ COCKPIT RAM AIR VALVE
④ ACS FLOW/TEMP CONTROLLER
⑤ ANTI–ICE ADD HEAT VALVE
⑮ VENT SUIT TEMP VALVE
④ ACS FLOW/TEMP CONTROLLER
③ COCKPIT RAM AIR VALVE
④ ACS FLOW/TEMP CONTROLLER
⑥ COCKPIT EMERGENCY VENT VALVE
⑨ LEFT AND RIGHT BLEED AIR PRESSURE REGULATOR AND SHUTOFF VALVES
⑩ ISOLATION VALVE
⑪ SECONDARY PRESSURE REGULATOR AND SHUTOFF VALVE
④ ACS FLOW/TEMP CONTROLLER
② COCKPIT AIR/DEFOG AIR DIVERTER VALVE (MECHANICAL LINKAGE)
⑫ LEFT AND RIGHT COCKPIT AVIONICS COOLING FAN
⑧ ANTI–ICE/RAIN REMOVAL PRESSURE REGULATOR AND SHUTOFF VALVE
⑬ EMERGENCY RAM AIR SCOOP (UNLATCHING SOLENOID)
⑭ ECM COOLING AIR VALVE
ECS
MODE
AUTO
MAN
OFF-RAM
TEMP
SUIT
CABIN
COLD
HOT
CABIN PRESS
NORM
RAM DUMP
ANTI ICE
PITOT
ON
AUTO
ENG
ON
OFF
TEST
BLEED AIR
NORM
AUG PULL
OFF
DEFOG
HIGH
NORM
LOW
WINDSHIELD
ANTI–ICE
RAIN
SPREAD
ECM
NORM

ECS SYMBOLS

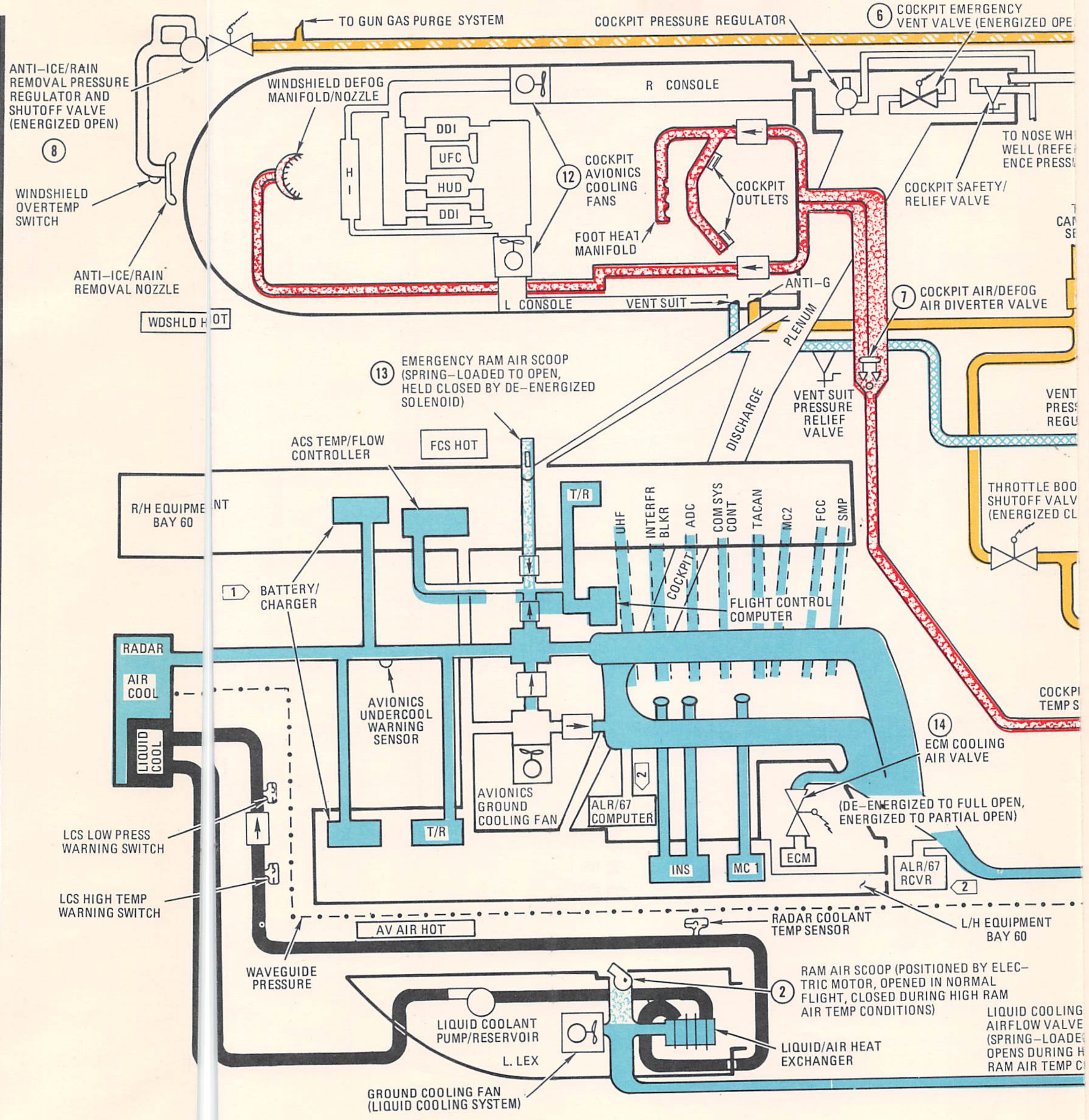
- –•– WAVE GUIDE PRESSURIZATION
- ---- SENSOR/CONTROL LINES
- —◆— ELECTRICAL CIRCUITS
- — — MECHANICAL LINKAGE
- ○ NUMBERS SHOW RELATION BETWEEN CONTROLS AND SYSTEM COMPONENTS CONTROLLED. NOTE THAT COMPONENTS WITHOUT NUMBERED CIRCLES ARE NOT DIRECTLY CONTROLLED FROM THE COCKPIT, AND THAT COMPONENTS WITH NUMBERED CIRCLES MAY ALSO BE CONTROLLED FROM SOURCES OTHER THAN COCKPIT CONTROLS.
- ← CHECK VALVE
- ◐ SHUTOFF VALVE
- ⊖ MODULATING VALVE
- ⋈ SOLENOID VALVE
- PRESSURE REGULATOR
- ▽ RELIEF VALVE
- TEMPERATURE CONTROLLER

- 🟦 REFRIGERATED AIR
- ▨ RAM AIR
- ▨ MIXED REFRIGERATED AIR AND RE-HEATED AIR
- 🟧 WARM AIR
- ▨ MIXED ENGINE BLEED AND WARM AIR
- LIQUID COOLING
- 🟥 ENGINE BLEED AIR
- ▨ HOT AIR
- ▨ RE–HEATED AIR
- ▨ MIXED ENGINE BLEED, WARM, AND REFRIGERATED AIR

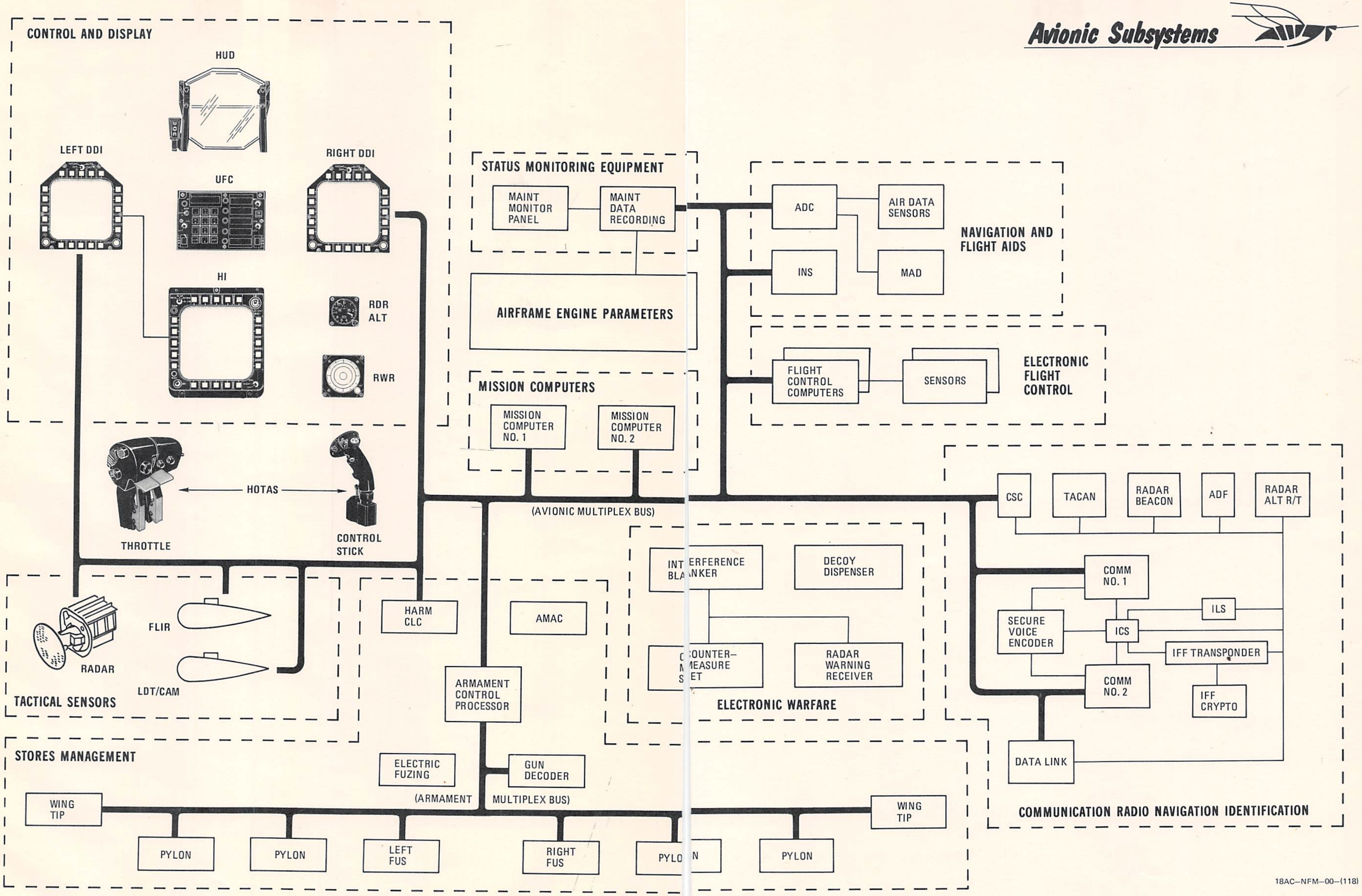
NOTES

1 161353 THRU 161528

2 161702 AND UP


TO GUN GAS PURGE SYSTEM
COCKPIT PRESSURE REGULATOR
⑥ COCKPIT EMERGENCY VENT VALVE (ENERGIZED OPE
ANTI–ICE/RAIN REMOVAL PRESSURE REGULATOR AND SHUTOFF VALVE (ENERGIZED OPEN)
⑧
WINDSHIELD DEFOG MANIFOLD/NOZZLE
R CONSOLE
DDI
UFC
HI
HUD
DDI
⑫ COCKPIT AVIONICS COOLING FANS
COCKPIT OUTLETS
FOOT HEAT MANIFOLD
TO NOSE WH WELL (REFE ENCE PRESS
COCKPIT SAFETY/ RELIEF VALVE
WINDSHIELD OVERTEMP SWITCH
ANTI–ICE/RAIN REMOVAL NOZZLE
WDSHLD HOT
L CONSOLE
VENT SUIT
ANTI–G
PLENUM
⑦ COCKPIT AIR/DEFOG AIR DIVERTER VALVE
CA SE
⑬ EMERGENCY RAM AIR SCOOP (SPRING–LOADED TO OPEN, HELD CLOSED BY DE–ENERGIZED SOLENOID)
DISCHARGE
VENT SUIT PRESSURE RELIEF VALVE
VENT PRES REGU
ACS TEMP/FLOW CONTROLLER
FCS HOT
R/H EQUIPMENT BAY 60
T/R
UHF
INTERFR BLKR
ADC
COM SYS CONT
TACAN
MC2
FCC
SMP
COCKPIT
FLIGHT CONTROL COMPUTER
THROTTLE BOO SHUTOFF VALV (ENERGIZED CL
1 BATTERY/ CHARGER
RADAR
AIR COOL
LIQUID COOL
AVIONICS UNDERCOOL WARNING SENSOR
AVIONICS GROUND COOLING FAN
2
ALR/67 COMPUTER
T/R
INS
MC 1
ECM
⑭ ECM COOLING AIR VALVE
(DE–ENERGIZED TO FULL OPEN, ENERGIZED TO PARTIAL OPEN)
COCKPI TEMP S
ALR/67 RCVR
2
LCS LOW PRESS WARNING SWITCH
LCS HIGH TEMP WARNING SWITCH
AV AIR HOT
RADAR COOLANT TEMP SENSOR
L/H EQUIPMENT BAY 60
WAVEGUIDE PRESSURE
② RAM AIR SCOOP (POSITIONED BY ELECTRIC MOTOR, OPENED IN NORMAL FLIGHT, CLOSED DURING HIGH RAM AIR TEMP CONDITIONS)
LIQUID COOLANT PUMP/RESERVOIR
L. LEX
LIQUID/AIR HEAT EXCHANGER
LIQUID COOLING AIRFLOW VALVE (SPRING–LOADE OPENS DURING H RAM AIR TEMP C
GROUND COOLING FAN (LIQUID COOLING SYSTEM)

Avionic Subsystems



18AC–NFM–00–(118)

Figure FO-9. Avionic Subsystems

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☆ U.S. Government Printing Office: 1983—664-019/2518